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xCoAx
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xCoAx 2019

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CONTENTS

ARTWORKS

PERFORMANCES

DOCTORAL SYMPOSIUM

COMMITTEES

SCIENTIFIC COMMITTEE

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FOREWORD

Welcome to the proceedings of the 7th edition of the Conference on Computation, Communication, Aesthetics and X, also known as xCoAx, which took place from July 3rd to July 5th 2019 in Milan, Italy.

Initially slated to take place at Politecnico di Milano, a place full of nostalgic value where several members of the organising committee first met a decade ago, xCoAx 2019 found a new home at Fabbrica del Vapore, a 30,000-square-meter former industrial complex converted into an art and performance space, to make room for the record number of submissions we received.

The week of xCoAx, from the set-up to the take-down, was one of the most torrid weeks that the city of Milan has ever seen, except during the massive thunderstorm on the evening of the opening (did you know styrofoam boards make for excellent umbrellas?), but all participants from 23 different countries seemed to be having a great time, without minding the heat too much. We suspect that a lot of help came from the folding fans and the iced bubble teas from the nearby Chinatown, one of the oldest and biggest in Europe.

However, the best distraction from a white-hot summer undoubtedly came from the very content of xCoAx. Firstly, we had a roster of excellent papers, which made for 6 exciting sessions that kept people discussing on AI, networks, art spaces, multiculturalism, globalisation, creativity and aesthetics, to name a few themes. Moreover, we were able to display an array of incredibly engaging artworks, divided into two spaces (a white cube and a black box), where traditional craftsmanship met the latest technology and where soundscapes, landscapes, seascapes and newscapes were remediated and reimagined by means of lights, screens, sensors, networks, walls, lasers and, of course, computers. The same multimedia versatility and dexterity to move back and forth between the material and the digital were on display during the performance evening, where a line-up of talented artists gave us a show that ranged from social activism and street art to minimal visual and aural aesthetics, all combined into a dazzling mix of networked experiences, media sampling, and gestural performances.

Several scholars were gracious enough to come and help us navigate with their wisdom through this 3-day extravaganza on computation, communication, and art. We had the pleasure of having Luciana Parisi from Goldsmiths, University of London and Domenico Quaranta from the Accademia di Belle Arti of Carrara as keynote speakers, whereas Simona Chiodo from Politecnico di Milano and Philip Galanter from Texas A&M University chaired the Doctoral Symposium.

This year more than ever the X of xCoAx has symbolised convergence: of interests, of competences, of perspectives, of cultures. An incredibly heterogeneous group of people came together to make it happen. It is difficult to explain in a few words what really happens at xCoAx, because so many different things occur. However, there is always an unmistakable sense of unity that underlies all of our efforts.

We hope that this book will succeed in delivering this feeling to you.

The xCoAx 2019 Organising Committee

Keynotes

Luciana Parisi: **Computational Design, Epistemological Possibilities and Machine Worlds.**

In the last fifteen years, the generic function of computation – or the rule-based processing of data behavior – has come to dominate the future image of architectural design. The aesthetic dimension of computational design speaks of a new technicity of contemporary culture corresponding to a machine logic of a world made of data. This technicity can be critically re-articulated from within a newly defined matrix of a naturing nature, namely engaging with what Gilbert Simondon would call the information processing in the constructions of forms. From this standpoint, this talk suggests that automated design has not simply led to the crisis of theory, model, or truth, but more importantly to the de-ontological realization that the infinity of

propositions – of the real outside – cannot be contained within a self-posing deduction that matches proofs to given truths. Computational design instead can overturn the ontological given as it takes technicity to its speculative level of knowledge, experimenting with axioms constructed within the recursive feedback of learning algorithms.

Domenico Quaranta: **Contemporary (Media) Art Between Hype Cycles and the Present Shock**

This lecture is an attempt to understand if, and how, art can exist in the present time. We know we are living an age that is profoundly different from that in which contemporary art is born: an age of acceleration, present shock, distracted gaze and end of the future. And yet, when it comes to art, we still confront it as if nothing had actually changed: as if it were the sacred result of moments of deep focus and concentration; as if it could still be experienced without distraction; as if it were the expression of a constant fight against the old, and of an endless rush towards the new; as if it could speak a universal language, and last forever. But it doesn't.
Rather than providing answers, this lecture raises questions such as: is it still possible to make art under these conditions, and to experience art as it should be experienced?
What's the price we have to pay for engaging today's media and the crucial issues of our time, in terms of duration and long term appreciation?

Although these considerations apply to all contemporary art, I use contemporary media art as the main area of reference, as I think most of the problems I'm outlining are more visible there, and more radically affecting the art that uses the tools and addresses the key issues of the post digital age. The lecture addresses sub-topics such as primary and mediated experience, the end of the future, Futurism vs Presentism, art's relation with art market dynamics and technological hypes, art's incorporation in the art system and in mainstream culture, obsolescence and media art preserv

Papers

xCoAx 2019 Conference on Computation, Communication, Aesthetics & X Milan, Italy

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The Spectre of Zombies is Haunting AI Art: How AI Resurrects Dead Masters, and Alternative Suggestions for AI Art and Art History

Keywords
AI
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deep art

In the past few years deep-learning AI neural networks have achieved major milestones in artistic image analysis and generation, producing what some refer to as 'art.' We reflect critically on some of the artistic shortcomings of a few projects that occupied the spotlight in recent years. We introduce the term 'Zombie Art' to describe the generation of new images of dead masters, as well as what we term 'The AI Reproducibility Test.' In conclusion, we propose new directions for both AI-generated art and art history, in the light of these new powerful AI technologies of artistic image analysis and generation.

1 INTRODUCTION

AI has been in the public eye and imagination for many years already, with endless scenarios describing the disappearance of different jobs and human skills, which will be taken over by intelligent machines. Artistic creation is no exception to this, as the question of mechanized artistic creation has been tantalizing human imagination for some decades. Recent breakthroughs in machine learning—especially in popular accounts—herald the achievement of this goal. While we applaud the progress in machine learning, neural nets, image recognition and manipulation, we question whether they constitute a major artistic breakthrough, at least in their current form. We suggest that by rethinking their conceptual goals and uses, more interesting AI generated art may be created. We further foresee a new frontier of AI based art history. For the purpose of our discussion we rely on three AI art projects which have at- tracted a substantial amount of media attention recently.

The Dutch *Next Rembrandt* project created by a multidisciplinary group of researchers, uses custom created AI to analyze the style and content of a large number of Rembrandt's paintings, then used them to produce a 'new Rembrandt portrait' (ING et al, 2016). The *DEEPART* project created by a German group of computer scientists. This project provides proof of concept that AI can successfully separate the content of an image from its style, and combine the style of one image with the content of another. Their well known example is an image which reproduces a picture of the contemporary city of Tübingen in the style of Van Gogh's *Starry Night.* The same software also generated images in the style of other artists based on that same Tübingen photograph (Gatys Ecker and Bethge, 2016a, 2016b).[1] Slightly different, the Parisian collective Obvious generated painterly portraiture images based on a large dataset of 14th-20th century portraits analyzed by deep learning neural net. It received a lot of publicity when one of its generated images, *Portrait of Edmond de Belamy*, was auctioned by Christie's in 2018 for 432,000$ (*Obvious,* 2018; Obvious, Explained, 2018; Schneider and Rea, 2018).[2]

In the following discussion we will refer to "artistic interest," "significance" and "value." Yet we consider art and its appraisal as a cultural phenomenon whose function and meaning together with its evaluations change through time and across cultures. Hence attempting to define such qualities is extremely difficult. However, we can delineate a bare minimum of connected traits that can stand as a correlate of artistic interest, signif- icance and value in the context of contemporary culture. These include: creativity, innovation and a sense of surprise.[3]

1. Currently it has opened a website, where people can select and send two images, one for content and the other for style, and the software generates a third image which is the amalgamation of the two images; see: https://deepart.io/#

2. There has been controversy around *Obvious'* use of its GAN algorithm, since it is virtually a copy of an algorithm created by Robbie Barrat and uploaded by him to *GitHub.* (Flynn, 2018).

3. The selection of these traits follows to a large degree, the article by Bringsjord, Bello and Ferrucci (2001), 5, 8.

2 THE SPECTRE OF ZOMBIES IS HAUNTING AI ART

2.1 AI as Forgery?

As much as we applaud these advances in AI Neural Networks, one might consider these projects as generating what we may call 'Zombie Art.' 'Zombie' because these machine algorithms generate paintings by masters that have been dead for centuries. Hence, a new painting in the generic style and content of Rembrandt, images in the unmistakable style of van Gogh, or any given image in the style of Munch's *Scream*. The possibilities are literally endless. We consider such images as technical assemblages existing in the space between the past and the present, life and death. These images are like the living dead or specters: they're zombie images, at once 'dead' and 'alive.' While it may certainly be considered an achievement to create a new artistic category such as AI generated zombie art, we question its actual artistic significance and interest. Aren't these images simply "'deepfakes'" (Hao, 2018).[4] Or simply put: machine made forgeries?

4. The term 'deepfakes' is currently a catch-all term for forgeries of images, videos, audio, etc., that are exceedingly difficult to detect due to their high quality achieved by advanced AI deep learning neural networks to generate or manipulate them.

Zombie art is not limited to machines alone. Human artistic forgeries of dead masters, such as the case of van Meegeren's fake Vermeers from the 1930s can also be considered as zombie art. The only difference is that the human forger injects a least a modicum of creativity to the forgery (though the goal of creating a passable fake will tend to limit such creativity). In the van Meegeren case, human forgery still relied on the artistic prowess and creativity of the forger, making the forgery unique. Therefore, human generated forgeries might be more accurately, and less provocatively, termed simply as 'forgeries.'

The creators of the Dutch *Next Rembrandt* project themselves describe their project along the lines of creating a forgery:

> because a significant percentage of Rembrandt's paintings were portraits, we analyzed the morphology of the faces in these paintings, looking at factors such as gender, age and face direction. The data led us to the conclusion that the subject should be of a Caucasian male with facial hair, between 30-40 years old, in dark clothing with a collar wearing a hat, and facing to the right. (ING et al., 2016)

Such a description of Rembrandt's (or any other artist's) characteristic subject matter that neatly corresponds to popular perceptions about him, constitutes the *sine qua non* of forgery; the real challenge of course is to fool the experts.

2.2 Averaging the Grand Masters

Our central criticism of these projects is that their forgery-like memetic aim constitutes precisely the reason why they are artistically underwhelming. Though we realize, that the emergence of such AI generated works already questions the current meaning of artistic value. These projects may be experimentally interesting from a technical perspective, but reading into the algorithmic process itself, we come to a conclusion that this process actually undermines the value of the original artworks themselves, before they were transformed into datasets. The generation of "new" Rembrandt paintings based on the datafication of his original oeuvres emphasizes the repetitive dimensions of his creativity, in a way that has so far eluded the human viewer of his work, thus diminishing the singular interest and value of Rembrandt's actual paintings.

However, we find a deeper problem with all three projects. Because the *aim* of these projects is to *emulate* the style and/or content of a specific artist's oeuvre, such image generation will inexorably zero in only on the most clearcut, characteristic and recognizable perimeters of an artist's style and/or content. By definition, this leads such projects to focus on the most obvious and redundant subjects and/or style traits of an artist, in order to generate a signature style and/or content. However, examining the Dutch Rembrandt project illuminates well this inescapable drift towards an art- ist's most distinct and popularly known traitsare alas, also the most trite characteristics of his oeuvre.

Yet Rembrandt did not acquire his reputation through a mere repetition of subject and style. As art Historian Christopher Wright writes in his book on 17th century Dutch painting: "one of the secrets of Rembrandt's subsequent reputation is [the] variety" of his oeuvre (1978, 172). Such variety is often divided into: history paintings of Biblical and classical subjects; landscapes; animals; self-portraits; portraits of family members; genre scenes of Dutch life; and portraits (Rembrandt Painting Net). Against this rich variety, *Next Rembrandt's* highly circumscribed focus on portraits of a Caucasian male in dark clothing etc., appear as limited.

Moreover, as the Dutch Rembrandt project video explains, once it was decided that the 'new' Rembrandt would be a portrait, they used various algorithms to extract average shapes of facial features such as eyes, noses and mouths from Rembrandts' portraits, and their facial proportions.

Next Rembrandt's project's drastic limitation of the image content and the idealized averaging of facial features as input data is the major reason why its 'new' Rembrandt portrait is underwhelming. While the 'new' portrait achieves a high level of painterly technique, this attainment is undermined by the very statistic averageness of its subject and style. Due to this averageness, for us, *Next Rembrandt's* 'new' generated portrait is ultimately dull since it does not contain any artistic surprises or novelty.

Similar dynamics are operative in the image generation of both the *DEEPART* and *Obvious* groups, although their algorithmic method is different. *DEEPART* attempts a balancing or averaging between content and style, in order to generate "visually appealing images" (Gatys, Ecker and Bethge, 2016a, 2419). But, creating pretty images by balancing the content/style parameters does not necessarily make for significant artistic images in our opinion. We find that actually many of the images created during the process, displaying unbalanced weightings of the content/style parameters are of greater artistic interest than the featured balanced ones, since they contain more surprises than the end result (Gatys, Ecker and Bethge, 2016a, Fig. 3).

In regards to *Obvious*, this dynamic of averaging or limitation is constituted in a different manner. *Obvious*' generation of portraits was achieved by inputting its deep learning neural net with "training data set of more than

15,000 portraits created between the 14th and 20th centuries" (Schneider and Rea, 2018). Yet the supposed variety of its input data is not that broad for two reasons. The first is artistic: historically, the genre of portraiture is the most durable and least changing genre in art history, due to its highly circumscribed conventions.[5] The second factor is the selection of input images; in *Obvious'* website they write: "[w]e carefully select a large number of input images with common visual features. The goal is to create a new sample that shares these features" Together these two factors emphasize commonality, rather than the variety of the input images.

Hence, all three projects are confined conceptually and operationally in a variety of ways, including limited inputs, the search for common features, averageness or an emphasis on an artist's most redundant traits. In our opinion, all these conspire to limit and restrain artistic creativity, novelty and surprise.

5. In portraiture painting, the focal point is always the face of the person (otherwise it isn't deemed a portrait); the face almost always looks at viewer or is slightly turned; there are only three central formats: full figure, 'half-shot' (only the head and torso are pictured), or it is a 'head-shot (showing only the face and shoulders); the figure is nearly always either standing or sitting, generally in an interior. Caselles-Dupré, of the *Obvious* collective is quoted saying that: "We did some work with nudes and landscapes, and we also tried feeding the algorithm sets of works by famous painters. But we found that portraits provided the best way to illustrate our point, which is that algorithms are able to emulate creativity." (Im, 2018) We suggest this is an implicit confirmation of our argument about their choice of genre.

3 OPEN-ENDED EXPERIMENTATION VERSUS PRESPECFIED GOALS

The projects mentioned above can be seen as an evolution of computer based generative art, which started with the early computer age. Those early artistic experiments with computers and current day AI art share many common features: creating the algorithms or neural nets; tweaking them; selecting the best images from a large output of generated images. As such it is instructive to place these works in the genealogy of generative art pieces. Yet there is a significant difference between these two approaches to using the computer creatively. The significant difference is the use of deep learning networks rather than non-learning algorithms. In other words, earlier generative art did not set forth to reproduce old masters, and therefore did not have to "learn" anything.

This highlights a significant difference between early computer-generated art, from the 1960s-1970s, and this new type of generative art. Early computer art was undertaken in the spirit of open-ended experimentation, without a specific goal in mind. As, Max Bense and Reinhard Döhl proclaimed, "The artist today realizes accomplishments on the basis of conscious theory and deliberate experiment[ation]" (1964, 9)[6]

6. See also Nake, 2005, 60, 93; Nake, 2012, 77.

In contrast, the projects of *Next Rembrandt, DEEPART* and *Obvious* are all directed towards their predetermined and specific goals, thus determining the modus operandi of these projects. Of course, these projects included substantial experimentation, yet this type of experimentation was most likely motivated by engineering rather than artistic purposes. Experimentation was not open-ended, but was rather of an instrumental kind, in order to achieve their pre-determined goals of imitative forgery-like artistic representations. Indeed, these projects' well defined teleology, constitutes one overarching reason that their results have only limited artistic value.

4 ART IN THE TIME OF AI: SUGGESTIONS FOR ALTERNATIVE USES OF DEEP LEARNING AI ART NETS

As we stated previously, we consider art and artistic value to be cultural and historical phenomena. Hence the emergence of such powerful new AI image analysis and generation technologies changes the current artistic ecosystem. Indeed, throughout history technology has always influenced and impacted art, for example: the ancient production of pigments, the invention of oil-based colors or the invention of photography.

We suggest that the use of deep learning AI visual networks could be utilized as an analytical tool, as well as, we believe, offering a potentially better way for generating artistic images. We begin with the question: what if, for example, Marcel Duchamp's entire oeuvre with all its different styles, mediums and genres was inputted into a deep learning neural network that has been trained to extract or distill a single artists' style, content, or both. What are the chances that such an AI neural network might succeed in this task and reproduce a new, yet recognizable Duchamp? We believe it would not be able to do so in any satisfactory manner. Most artists have a single 'mature style.' Yet there are artists that among their prominent signature is their simultaneous (or rapidly changing) creations in many artistic styles, genres and mediums. The names of Francis Picabia, David Smithson, Gerhardt Richter and Sigmar Polke, among others come to mind as being such multitudinous artists.[7] Inputting their entire oeuvres into such a deep neural network, as described above, might not yield impressive mimetic results. Therefore, we suggest the possibility of what we call '*The AI Reproducibility Test.*' The test would consist in seeing whether a deep learning AI net, inputted with the entire oeuvre of a single artist, will be able to generate novel images commensurate with that artist's oeuvre, or not. It is perhaps possible, that such a hypothetical test would yield a clear demarcation between artist's whose oeuvre allows for such generation of images, against those that don't. However, more realistically, we think the outcome of such a test would be a spectrum of results, ranging from high ratings for artists whose oeuvre will easily abet the generation of new images in their signature style and/or content to those artists with which the neural networks will only achieve limited or unsatisfactory results and receive a lower rating. We suggest that this would perhaps constitute the beginning of new forms of engagement of AI with art history, that might well lead to interesting new insights regarding artistic practices. We can even imagine a possible future scenario in which the relative ranking of contemporary, working artists in *'The AI Reproducibility Test.'* would become significant; thereby, likely influencing artists to attempt creating oeuvres that would produce lower 'Reproducibility Test' ratings.

In the context of the projects we discussed above, which ultimately generate new images based on the input of already existing ones, we propose that in regards to individual artists' oeuvres, the more interesting results will come from those artists whose *'Reproducibility Test'* ratings are at the lowest part of the spectrum; i.e., cases where neural nets will not be able

7. Other contemporary multitudinous artists include the likes of: Bruce Nauman, Albert Oehlen and Martin Kippenberger.

to satisfactorily distill their style and/or content. Such supposed 'failures' will serve as kind of constraint on the neural net's tendency to focus on the most reoccurring features of an artist's work. Just as importantly, it will likely diminish, severely skew or avert the seemingly insistent drift toward the averaging by the nets' operations. Thus, generating novel images based on hard to reproduce artists will generate images that would be 'off-kilter' and this will likely generate more surprising, unexpected and potentially more creative images in our view.

To conclude, we find the strength and significance of these AI based projects, not in the production of new, out of context paintings by dead masters, but rather in the creation of a new approach to art history through the eyes of 21st century intelligence. If our machines can now paint a 'new Rembrandt,' and separate between style and content, can we use them to learn new things about the processes, significance and meanings of artistic creation throughout human history?

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Can you fool the AI? Investigating people's attitudes towards AI with a smart photo booth

With the increasing impact of AI in people's everyday lives, multidisciplinary research on the public perception and understanding of AI is more important than ever. Yet, such research is still scarce. In this paper, we present a novel and playful setup for evaluating the impact of actual Human-AI Interaction on people's attitudes towards AI. The proposed setup takes the form of an intelligent photo booth capable of identifying humans. We present a first pilot study, illustrating how this AI system could be used in research. During this pilot, visitors of a film festival were challenged to fool the AI and take a selfie on which the intelligent photo booth would not identify them as a human being. Participants' attitudes towards AI were measured before and after the interaction. Based on exploratory observations, we conclude that multidisciplinary research into AI attitude, Human-AI Interaction and AI literacy is a promising research direction.

1 INTRODUCTION

Artificial Intelligence (AI), the ability of a computer or robot to perform tasks that are commonly associated with intelligent beings (Copeland, 2019), plays an ever-increasing role in people's everyday lives. To mention just a few examples: video services, music platforms and webshops present customers with AI-driven recommendations. Smart assistants, such as Amazon's Alexa or Apple's Siri and AI-powered chatbots answer people's questions. Likewise, AI-based travel advice determines people's route to their destination.

The increase of AI in people's lives raises many questions: How do people think and feel about AI? Can they recognise, understand and evaluate the processes involved in AI-driven decision-making? What mental models do they use when interacting with AI systems — are these models similar to those of humans or more like models of machines? In this paper, we emphasise the need to address such questions concerning AI attitude, the public understanding of AI and Human-AI Interaction from a multidisciplinary perspective, combining expertise from both social science and computer science. We present a novel and playful setup for conducting such research in the context of face detection. The proposed setup takes the form of an intelligent photo booth capable of detecting humans (as well as various objects and animals) on digital images. We illustrate how this setup can be used for research with a pilot study. In our pilot, participants were challenged to fool the AI and take a selfie on which the intelligent photo booth would not identify them as a human being. Participants' attitudes towards AI were measured before and after the interaction.

The core objective of the paper is to spark more multidisciplinary and playful research into AI attitudes, AI literacy and Human-AI Interaction by sharing our approach and experiences. A key contribution of our work is the presentation of many urgent, societally and culturally relevant questions in the AI research landscape.

1.1 Concept

The general idea of our research is to let people interact with an AI system and to investigate whether and to what extent this affects their "AI attitude". The interactive installation presented in this paper asks people to fool an AI system. This idea is rooted in the observation that machines are getting smarter and smarter, and the consequent question whether we humans are still smart enough to fool intelligent systems. More specifically, it is relevant to see how perceptions of human abilities to outsmart AI affect attitudes towards AI.

The proposed setup explores people's attitudes towards AI in the context of automated face detection. The ability to detect faces in digital images has many applications. For instance, face detection is used in digital cameras so that faces in the picture will be captured sharply. Also, face detection is necessary to subsequently analyze the face further, e.g., to estimate a person's emotions based on facial expressions. More importantly, it is also a first necessary step for face recognition. In other words, faces need to be detected first in order to then identify the person.

Ultimately, our project could have been realized with many different AI systems. We chose the context of face detection due to the combination of five factors: First, we believe it is important to approach AI not as a future technology, but as something that is already affecting people's lives. Face detection and subsequent face recognition is a form of AI many people are already affected by (e.g., people increasingly unlock their phones by presenting their face to the built-in camera). Second, face detection and recognition are controversial topics, which play into issues of surveillance, privacy and security. These topics are very societally relevant and also will benefit from a multidisciplinary approach. By combining the topic of AI and the topic of face detection, we can address several urgent issues at once. Third, face detection often happens without the person's consent and potentially can take place without the person being aware of this. For instance, in surveillance contexts people might not be aware of the camera or might not be aware that a machine rather than a human analyzes the images. This sets face detection apart from other kinds of (well-studied) AI experiences — such as interaction with robots or digital assistants — where people are more likely to be aware of the AI system and intentionally interact with it. By presenting people with a face detection AI, we hope to raise their awareness about such 'hidden forms of AI' and aim to gain more insight in how people are affected by interaction with less obvious forms of AI. Fourth, face detection is something humans are very good at themselves, which makes it an easily accessible topic for research with the general public. Fifth, it is relatively easy to determine the success and failure of a face detection AI system. A suggestion by a recommendation system, for instance, is more difficult to classify as a success or failure. Likewise, it is easy to assess if a person has managed to stay undetected. Such clear distinctions are beneficial for us, as we are interested to see if people's opinion about AI is affected by how successful the AI is and by how successfully they can control the outcomes of their interaction with the AI.

Due to the multifacetedness of the topic, the resulting installation allows us to address many questions. In addition to studying the attitudinal effects of interaction with AI systems, we are also interested how people feel and think about AI in general. We have designed our installation as a tool to answer these questions and as an exhibit that fosters reflection and conversation around the topic of AI.

2 RELATED WORK

Not surprisingly, the increase of AI in people's lives goes hand in hand with an increase in research about the relationship between humans and AI systems. In particular, existing research addresses humans' interaction with robots (e.g., the survey by Goodrich, Schultz, et al., 2008), their experience with virtual agents (e.g., Cassell & Tartaro, 2007), chatbots and virtual assistants (e.g., Klopfenstein, Delpriori, Malatini, & Bogliolo, 2017) as well as intelligent user interfaces (e.g., Ross, 2000). Also, specific AI-driven tools, such as recommendation systems have been actively studied (e.g., Park, Kim, Choi, & Kim, 2012).

Surprisingly, so far little focus has been put on the general public's attitude towards AI. It stands to reason that people's thoughts and feelings towards AI are, amongst others, shaped by mass media (e.g., articles about AI and movies depicting (future) AI systems) as well as by their own personal experience with AI systems. Whether and to what degree this is the case, still needs to be explored. This paper takes up these questions and proposes a setup to investigate whether interaction with AI affects people's thoughts and feelings about AI.

2.1 Fooling face detection and recognition

Our installation challenges participants to fool a face detection system. This topic has been explored before, both in the arts and in the sciences. In the art context, fashion has been proven a powerful tool to evade face detection (an overview is provided by Davis, 2014). For instance, the designer and technologist Harvey (2011) has presented CV Dazzle — a camouflage from face detection that is based on applying makeup, wearing fashion accessories and styling the hair in a way that prevents the widely-used Viola-Jones face detection algorithm (Viola & Jones, 2001; Viola & Jones, 2004) from recognizing the face. Simply put, this face detection algorithm makes use of the fact that human faces share similarities, and that some areas of a face are generally darker or lighter than other areas.

Another artistic project by Harvey (2017) that aims at fooling face detection is Hyperface. To protect the wearer from face recognition technology, the project uses clothing with special abstract patterns, which contain 'false faces' that distract facial detection systems from the wearer's real face.

A similar approach is used in the REALFACE Glamoflage project by Simone C. Niquille, who designed t-shirts to fool Facebook's face recognition as part of her Master thesis (in Barribeau, 2013). Like Hyperface, her t-shirts present face recognition systems with many faces. However, here the faces are no abstract patterns — instead, the t-shirts feature an artistically designed collection of actual faces of famous people, ideally tricking the system in, e.g., identifying the face of Michael Jackson or Barack Obama rather than the face of the wearer.

The URME Surveillance project by artist Leo Selvaggio (2015) similarly focuses on making cameras identify the wrong person. The artist distributes masks of his own face that people can wear so that they are identified as him.

In the scientific domain, researchers have taken up the ideas proposed by artists. In particular, Feng and Prabhakaran (2013) build on the work by Harvey (2011), and propose a tool to help artists and designers in creating camouflage-thwarting designs. Their tool finds prominent features that cause a face to be recognized and presents suggestions for camouflage options (makeup, styling, paints).

Yamada, Gohshi, and Echizen (2013) propose a wearable prototype similar to eyeglasses that is meant to prevent unauthorized face image revelation. Like Harvey's CV Dazzle, the project is set up to change the apparent features around the eyes and nose, which are used in the Viola-Jones face detection process. Instead of makeup and hairstyles, their device is based on transmitting near-infrared signals. These signals are picked up by camera sensors and corrupt the captured images, rendering the faces in the captured camera images undetectable.

The project by Sharif, Bhagavatula, Bauer, and Reiter (2016) also requires the user to wear specific glasses. However, in contrast to previously reviewed approaches, it focuses on face recognition realized with deep neural networks (DNNs). They propose techniques for generating eyeglass frames that allow the wearer to evade being recognized and even to impersonate other individuals.

Finally, a related area of research concerns face de-identification, which refers to the removal of identifying information from images (see, e.g., Gross, Sweeney, Cohn, De la Torre, & Baker, 2009). A well-known example of face de-identification is blurring faces. Our own project focuses on real-world measures that people can take in the physical domain to prevent face detection rather than on digital modifications. Because of this, such face de-identification approaches as well as digital adversarial attacks, fall out of the scope of this paper. Yet, it should be mentioned that similar questions are addressed with a focus on the digital domain. For instance, Wilber, Shmatikov, and Belongie (2016) explore whether people can still circumvent face detection on Facebook by applying various image filters to photographs.

As this short review shows, the topic of fooling face detection has been actively explored. Our project takes these efforts as an inspiration. However, unlike many existing projects it does not propose a new tool to evade face detection and is not aimed at enabling people to fool face detection, nor is it interested in building more robust face detection mechanisms that cannot be fooled. Instead it is designed to research people's attitude towards and interaction with AI and to provide a thought-provoking and intriguing experience.

3 *MISIDENTIFY.ME:* THE INTELLIGENT PHOTO BOOTH

In order to study whether and how interaction with AI systems affects people's attitudes towards AI, we created an 'intelligent photo booth' application. The resulting system is called "misidentify.me" (see Figure 1) and it is smart in the sense that it is able to detect humans as well as identify a range of objects and animals. In the context of our pilot study, the system was presented in an ad-hoc photo booth, next to a table with masks and makeup and a short text describing the installation and the challenge. However, the system can also be used online. In the following, we will describe this core part of the system as well as how we have presented it in the context of the festival.

Fig. 1.
The *misidentify.me* installation at the InScience film festival

3.1 Interaction design

The front-end and user interaction of our installation was designed as follows: The user is greeted on a start-screen where a text challenges them to fool the AI and to take a selfie on which they are not identified as a human being. The screen features two primary buttons, allowing them to participate in the experiment or to simply try to fool the AI without taking part in the study. The screen also shows a digitally mirrored version of the webcam input, allowing the user to see themselves in front of the computer. On this image, the position of their face is highlighted with a rectangle, using a face detection mechanism described below. This makes sure the user can see that the face detection is working and gives them an immediate idea of what the project is about. After selecting either option, the rectangle around their face disappears, and one primary button allows them to snap a selfie. In the film festival exhibit, people could now use makeup or masks that were provided (see Figure 1) or come up with their own strategies to fool the AI. However, it is also possible to attempt the challenge without such appliances, e.g., by using one's hands to cover the face. [1]

Once the selfie has been taken, users can either retake the image or submit it to the AI. When submitted to the AI, the image is analyzed and a label appears on the image, presenting the system's verdict: either that the user is a human and the confidence that this is the case, or that they are something else, specifying the object or animal that the system recognized and its confidence about this decision (see Figure 2). In case the person is identified as a human, their face is again highlighted with an enclosing rectangle. This result-screen allows the participant to try fooling the AI again, or to exit the experience.

1. Ideally, we would stimulate them to use their own strategies instead of steering them into a certain direction by providing the materials. However, because of the festival context, we adopted a more entertainment-oriented approach.

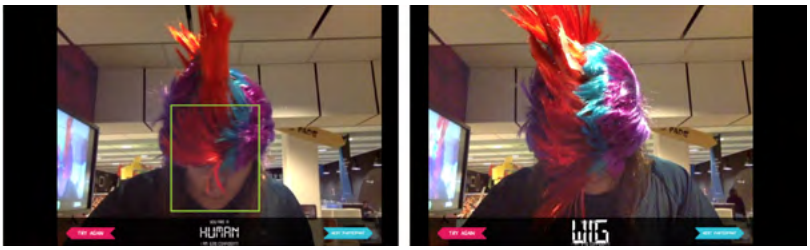

Fig. 2.
The result-screen.

3.2 Hardware

On the hardware side, the installation only requires a computer and a webcam, and any relatively modern laptop should suffice to run the experience. In the festival context, the misidentify.me installation was run inside an old voting booth that was re-purposed as an ad-hoc photo booth. A 15” Macbook Pro from 2015 was placed within the booth, with a mouse and a USB number-block for usability reasons. The build-in camera was used to take the visitors’ selfies.

3.3 Software

On the software side, misidentify.me is realized with web technologies. This is done to also offer the experience online and to extend the study with an online experiment in the future. However, during the festival, everything was run locally. The core functionalities are realized with the combination of p5.js (see https://p5js.org/) and ml5.js (see https://ml5js.org/).

The p5.js library is a JavaScript client-side library for creating visuals and interactive experiences, and it is used to facilitate the overall interaction and user flow. The ml5.js library is an easy-to-use wrapper around the widely-used TensorFlow.js (https://js.tensorflow.org) library for machine learning, and provides access to machine learning algorithms and models in the browser. (We chose this particular library because it allows researchers with no or little machine learning experience to understand and possibly adapt the code. This is ideal for multidisciplinary teams.) Among other things, ml5.js supports the use of pre-trained models for detecting human poses and image classification. In the misidentify.me installation, ml5.js is used to analyze the submitted selfies. Two machine learning models are used in combination: One to determine what we called the ‘humanness’ of the image and one to determine the ‘somethingness’ of the image. We made sure that in the end, the system has to decide whether it is dealing with (1) a human or (2) something else (an object or animal). In the former case, the image is labeled with the term “human” and a rectangle indicates the position of the human’s face. In the latter case, the name of the identified object/animal is reported. In both cases, a confidence score accompanies the result.

To estimate the ‘humanness’, the ml5 version of PoseNet — a machine learning model for real-time human pose estimation — is used.[2] PoseNet can detect a human figure in an image (or video) and estimate the position of key body joints. We use the information about five keypoints, namely the nose, left eye, right eye, left ear and right ear to estimate the probability that the image contains a human. (We only focus on the face as selfies potentially solely focus on/contain the face.) In our setup, this ‘humanness’ is simply the average (mean) of the confidence scores of the five face-related keypoints mentioned above. Strictly speaking, this score describes the confidence about the accuracy of the keypoints. Yet, our informal tests revealed that the score works well for our purpose. To decide whether the

2. Alternative face detection methods were tested, and PoseNet was chosen based on informal testing as it provided a good balance between successfully detecting faces and the possibility to fool the system.

image should be labeled as “human” or not, the ‘humanness’ score is compared with a ‘somethingness’ score.

The ‘somethingness’ score is determined with a MobileNet model for image classification. Here, the ml5 library accesses a pre-trained model that was trained on the ImageNet database (Deng et al., 2009; Image-net.org, n.d.) consisting of over 15 million images. It knows 1000 different classification categories (objects and animals). When submitting an image, this model outputs the top three hits and their probability. For the ‘somethingness’ score, we simply use the probability of the top result.

As mentioned, the two scores are compared. If the ‘humanness’ score is bigger than the ‘somethingness’ score, the image is labeled as human. Otherwise, the label of the object/animal that has been identified is presented to the user. In both cases, the confidence (the winning score) is reported as well.

To record the results of those users who give consent and choose to participate in the study, information is written to a JSON file with the Node.js (see https://nodejs.org/en/) web application framework Express (see https://expressjs.com). We record the participant ID to link the data to questionnaire data that we collect with the survey platform Qualtrics (see https://www.qualtrics.com/). Furthermore, we record the result that has been presented to the participant and the displayed confidence about the result. Finally, we record the ‘humanness’ score and the top three labels returned by MobileNet and their probabilities. Ideally, we would save the selfie for further analysis (e.g., to analyze them for used strategies). Unfortunately, we were not able to obtain ethical approval for such a study yet.

4 PILOT STUDY

We used the above described installation in a two-day pilot study at the InScience science film festival in the Netherlands. The following sections illustrate how our setup can be used for research into the public attitude towards AI. To guide our exploratory analyses, and in line with prior research and theory (e.g., Ryan & Deci, 2000; Dietvorst et al., 2018), we expected that participants who succeeded in not being identified as a human would have a more positive attitude towards AI, as it can be hypothesized that fooling the AI gives them a sense of greater control over AI technology.

4.1 Design

We used a quasi-experimental 1 factorial (identified as human yes/no) pretest-posttest design, in which two dependent variables – thoughts and feelings about AI – were measured both before and after interacting with the smart photo booth. Participants were allocated in one of two groups, depending on whether or not the AI was able to identify them as humans. The researchers obtained formal approval for the study from their institution’s ethical committee beforehand.

4.2 Participants

Participants of the experiment were festival and library visitors and acquaintances. While everyone was allowed to use the photo booth, only adults were allowed to participate in the study. In total 42 adult users took part in the experiment. Unfortunately, after cleaning the data and removing the data from participants with incomplete answers, only data from 25 participants (21 Dutch, 2 Italian, 1 Finnish, 1 German) remained. The remaining participants were between 20-70 years of age (M=33.25, SD=14.53). 8 participants identified as male and 17 as female. Participants were relatively well educated with 18 participants having either completed or currently pursuing a university degree. 3 participants reported a background in artificial intelligence or data science and another six participants had other IT related backgrounds.

4.3 Procedure

Adult visitors of the festival and/or library either approached us or were approached by us. They were then asked whether they are interested in interacting with our installation and fooling an AI. If interested, visitors could choose to simply play with the system or to participate in the study. In the latter case, active informed consent was obtained before participating. Subsequently they were asked to fill in a pretest questionnaire on a tablet. The pretest questionnaire stated a definition of AI, to make sure everyone was thinking about the same kind of systems. Subsequently, they got one shot at fooling the AI. (However, they could retake the selfie until they were satisfied.) After being informed of the result, they were asked to fill in the posttest questionnaire.

4.4 Measures

We administered a pretest and posttest questionnaire via Samsung tablets. The questionnaires were presented in Dutch (see www.misidentify.me/questions.pdf for an English version). Both questionnaires measured attitude towards AI in general, with attitude being seen as the participants' thoughts and feelings about AI. Using a Visual Analogue Scale ranging from 0-100, 15 questions addressed *feelings about AI* ('How do you feel about AI in general?'), with answers e.g., anxious-calm, good-bad, or inferior-superior. Likewise, 11 items regarding *thoughts about AI* ('I think AI is... ') included e.g., useful-useless; predictable-unpredictable, or risky-safe. The order of the items was randomized for each participant. Factor analyses showed one factor for the 15 *feelings* items, and one factor for 9 out of 11 *thoughts* items. Accordingly, mean scores were calculated for both variables and entered into the analyses, with scores ranging from 0 (most negative) to 100 (most positive). Cronbach's α's for pre and posttest scales ranged from .67-.95.

In addition to these questions, the posttest questionnaire measured demographics and included questions about their experience with the intelligent photo booth (e.g., whether they were surprised by the outcome), and more general (control) questions (e.g., interest in AI, usage of AI in daily lives, AI-related media consumption and whether participants had a background in AI).

4.5 Results

Of the 25 participants with complete datasets, 12 were correctly identified as a human and 13 were not correctly identified as human beings. Of the 13 selfies that were not labeled as human, 10 selfies were labeled as something else (4 masks, 3 wigs, 1 bow, 1 windsor tie, 1 lampshade). For the remaining 3 selfies, the AI did output the label human, but did not associate this label with the participant (e.g., in two cases it detected some other person in the background). We checked whether the participants were distributed randomly across the two conditions. There were no significant differences between the two conditions in terms of gender, age, education, background in computer science, information technology, AI or data science ($Range_p$ = .286-.863). Because of the small number of participants, no inferential analyses were conducted and only descriptive statistics are provided.

Table 1 shows the general feelings and thoughts about AI were more on the negative side, with a score well below the midpoint of the 0-100 scale. In addition, the pretest and posttest data suggest that once participants had interacted with the photo booth, their feelings and thoughts became even more negative.

	Feelings		Thoughts	
Pretest	*M* (SD) 36,73 (15.63)	Min-Max 1-63.80	*M* (SD) 40.79 (10.57)	Min-Max 16.56-57.44
Posttest	*M* (SD) 32.70 (16.39)	Min-Max .87-64.0	*M* (SD) 35.97 (14.90)	Min-Max .89-56.89

Table. 1.
Descriptive statistics (N=25)

When comparing the means for the two conditions, it seems that participants had a more positive attitude towards AI when they succeeded in fooling the AI.[3] In the group that was not identified as human, mean posttest scores for feelings were higher (*M*= 34.68, *SD*=17.85) than scores in the group that was identified as human (*M*= 30.56, *SD*=15.12). Likewise, thoughts about AI were more positive in the group that succeeded in fooling the AI (*M*=37.88, *SD*=15.5) than in the group that did not (*M*=33.90, *SD*=14.57).

3. With “fooling the AI” we refer to the objective outcome that the person was not identified as a human being – not to the subjective experience of having fooled the AI.

5 DISCUSSION

In what ways and to what extent does interaction with an AI system affect people’s thoughts and feelings about AI? Unfortunately, based on the little data collected so far, we cannot present a definite answer to the question. In our opinion, the small sample size does not justify inferential analyses.

However, it stands out that people's AI attitude was generally more on the negative side. We suggest to evaluate whether this is indeed the case for the general population, and if so, research the cause of people's negative thoughts and feelings.

Furthermore, we notice that all posttest scores are lower than the pretest scores. This is particularly interesting because many participants were impressed and amused by the AI, which could explain a more positive AI attitude. Hence, it seems promising to research whether interaction with AI leads to a significantly more negative attitude towards AI regardless of the outcome of the interaction. Also, it would be interesting to see if interactions with different types of AI systems (e.g., a AI-driven chatbot) affect people's AI attitude in different ways. Finally, our study provides first indications that when people 'outsmart' the technology, their attitudes toward that technology are more positive.

The many conversations and informal observations revealed that our installation creates AI awareness and fosters dialogue and reflection. Our observations reaffirm that at least some people seemed rather surprised and impressed by the capabilities of the AI system and/or the outcome. In our opinion, this is especially interesting because similar AI technology is already a part of many people's everyday lives. The fact that people nonetheless respond this way raises the question whether people are aware of the AI systems that are already part of their lives and highlights the need for research into what we call "AI literacy" — the question whether people can recognise, understand and evaluate the involvement of AI systems when using technology.

Our pilot study shows how the misidentify.me installation can be used for scientific research. Our hope is that people learn from the limitations of our study and the mistakes we have made. We have only allowed people to submit one selfie. One single interaction might be too little to have a measurable effect on people's attitudes. For future studies, we suggest to allow people to interact with AI systems repeatedly. Another limitation of our research was that the questionnaire was only presented in Dutch, with on-the-fly translations for non-Dutch participants. Also, our questions about attitude (thoughts and feelings) were designed specifically for this study, and validated measures of these constructs would be very desirable. Finally, the distinction into two groups based on whether participants were identified as human was more difficult than anticipated. Although many people were not identified as humans, the AI labelled several people who were wearing a mask with the term "mask". While some of these people felt like they had fooled the AI, others did not feel like the AI was fooled (after all, it did not make a mistake). We used the objective result rather than the subjective experience in this study. However, we believe it is important to also take participants subjective experience into account in the future.

The installation of this study was designed to create a good balance between people who are identified as a human and those, who are not identified as a human. This was successful. On the one hand, the fact that AI systems could (at times), easily be fooled raises questions about their security and robustness. With respect to this, it has to be noted that other AI systems likely perform much better. On the other hand, some people were not able to fool even our rather basic AI. This raises the question of people's control and agency in a society where smart machines are ubiquitous. We suggest to address such questions in future research.

The experiment was held as part of a film festival. Informal conversations made it very plausible that films can shape people's attitudes towards AI technology. We hope to validate this observation outside of the scope of a film festival. More generally, we believe it would be interesting to test the setup in different contexts.

Aside from the proposed study design, the main outcome of our study is not the answers, but the questions that have been raised during the project. We hope this setup will inspire future research, and suggest researchers to have a look at our questionnaires (www.misidentify.me/questions.pdf). We believe that in order to address questions of AI attitude, AI literacy and Human-AI Interaction, a multidisciplinary approach is needed. Whereas existing AI research mostly focuses on the technical challenges underlying effective and robust AI systems, the effect that these systems have on people is often overlooked. For instance, many researchers try to develop computational methods to extract meaningful information from machine learning models (so-called 'explainable AI'), but such research can be nicely complemented with insights into how human beings generate and process explanations (Miller, 2018). Hence, in our opinion, to make sure the future of AI is truly "social AI", computer science and the social sciences need to go hand-in-hand in a way that is not unlike co-evolution: computer science needs the expertise of social science (e.g., communication science) to understand the effects that developed AI systems have on people. At the same time, the social sciences need the computer sciences to develop and improve existing systems according to their findings (Bosse, 2019). The project presented in this paper is a collaboration between AI/HCI and communication science researchers. Only together, we were able to build the system and set up this study. For future work, we plan to run this study online, allowing people to fool the AI in the comfort of their own homes. With this project, we hope to spark more experiments about the relationship between humans and AIs.

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Imagining Intersectional AI

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Artificial intelligence should be created and used with more critical thought to the biases and ideologies baked in. This paper surveys current research contextualizing the stakes of AI discrimination and looks to intersectionality as a set of overlapping frameworks applicable to AI for both analysis and tactics. It argues that intersectional approaches need to be implemented widely, in community, and throughout the entire AI pipeline—from development and implementation to cultural absorption and material impacts. Although that vision is far from being fully realized, this paper points to examples suggesting how experimental engagements with AI can help imagine its intersectional futures.

1 INTRODUCTION

Artificial intelligence is quietly shaping social structures and private lives. Although it promises parity and efficiency, its computational processes mirror biases of existing power structures even as often-proprietary data practices and cultural perceptions of computational magic obscure those influences. However, intersectionality—which foregrounds an analysis of institutional power and incorporates queer, feminist, and critical race theories—can help to rethink artificial intelligence. An intersectional framework can be used to analyze the biases and problems built into existing artificial intelligence, as well as to uncover alternative ethics from its counter-histories.

While offering tools for critical analysis of existing technologies, intersectionality can also shift approaches to creating new technologies. This paper, after contextualizing current arguments around AI bias and intersectionality, examines strategies from Black feminist, mixed race, and queer communities to show how these might be applied to algorithm design and implementation in culture. It argues that AI should be created and critiqued with an awareness of power – and reframed using intersectionality – to value multiple epistemologies, methodologies, and perspectives in order to address the social inequalities it reinforces. Finally, it uses case studies to sketch out a preliminary proposal for imagining intersectional artificial intelligence that can disrupt hegemonic structures and uncover its subversive procedural potentials.

2 AI AS AUTHORITY, AI AS MIRROR?

Bias manifested through the use of algorithms and artificial intelligence carries high stakes, in part because it is has the potential to put some populations at much higher risk. Safiya Noble (2018) argues “algorithmic oppression” is hard-coded into the algorithms that support AI and the very systems that determine much of day-to-day subsistence, “creating and normalizing structural and systemic isolation, [...reinforcing] oppressive social and economic relations” (10). Miriam E. Sweeney (2016) points out that in the design of artificial agents, “the normative subject is usually constructed as White, male, and presumptively heterosexual, and therefore unproblematic and uncomplicated as a design option. Female and non-White identities are seen as potentially problematic” (222). What gets framed as a matter of preference is linked to a system in which whiteness holds more value (Niesen 2016, 171). Despite the democratizing promise of digital technologies, identity markers are reinforced and even extracted as capital through (in)voluntary participation in algorithmic systems. In one of the more troubling cases of algorithmic bias, *ProPublica* analyzed the proprietary algorithms used to create criminal risk assessments – predictions which affect the harshness of sentencing:

> The score proved remarkably unreliable in forecasting violent crime: Only 20 percent of the people predicted to commit violent crimes actually went on to do so. […] The formula was particularly likely to falsely flag black defendants as future criminals, wrongly labeling them this way at almost twice the rate as white defendants. White defendants were mislabeled as low risk more often than black defendants. (Angwin et al 2016)

This example is among many "well-documented biases that should not have been news" and that precede digital technologies (Chun 2018, 64) but whose biases are further disguised by algorithmic systems.

These systems have incredible impact not only because they operate en mass, outside individual control, but also because AI's mythology allows them to assume the status of impartial fact even as they operate by human interpretation and intervention at every level. The embodied human—while missing from the marketing of AI as superior for its detached, emotionless decision making—remains key to AI's operation: "a human interlocutor is needed to keep artificial systems functioning effectively. All AI is HCI [(human–computer interaction)]" (Wilson 2010, 103). This labor is horrifyingly evident in the field of commercial content moderation (CCM), which Sarah T. Roberts (2016) argues lends a dangerous sense of naturalization to racist and biased content because of the perceived computational role of AI rather than human choice: "Companies' desire to keep CCM work in the shadows therefore gives the impression that such content is just what is out there in the culture in some kind of natural, organic way and hides the human decision-making processes and curation work from the view of their user-participants" (157). Here AI "autonomy" is carefully curated for corporate profit, but contingent on human systems—who are acting as technology and who are ignored and exploited on its behalf.

That curated cultural understanding of AI overlaps with the big data it utilizes and with specific types of AI like deep learning and neural networks, and so it is important to distinguish that this discussion focuses on "narrow" AI, which is various in kind and is implemented toward specific objectives such as purchase recommendations, news feeds, etc.—not "general" or "strong" AI, which remains speculative and conjures dystopian fears of the singularity. The conflation of the various types of artificial intelligence contributes to its mystique, allowing it to operate with an aura of unquestioned truthiness. This is compounded, claims Luciana Parisi (2017), by the structures of binary problem-solving, "which values making a clear decision quickly more than it does making the correct one" (1). These fuzzy understandings do little to undo the infrastructural inequalities embedded in the design and implementation of many AI.

3 INTERSECTIONALITY IS NOT JUST MORE REPRESENTATION, NOT JUST MORE DATA

Reading artificial intelligence through an intersectional lens can help decode and critique these power structures, and using intersectional approaches to design and implement artificial intelligent systems creates the possibility for restructuring them. Intersectionality is not merely shorthand for discussing individual identity representation by accumulating strings of hyphenates; rather, it examines and critiques systems of power and how those systems structure themselves to impact groups and individuals unequally. Brittney Cooper (2016) re-articulates the definition of intersectionality to distinguish it from how it has been oversimplified and misused:

> Intersectionality's most powerful argument is not that the articulation of new identities in and of itself disrupts power arrangements. Rather, the argument is that institutional power arrangements, rooted as they are in relations of domination and subordination, confound and constrict the life possibilities of those who already live at the intersection of certain identity categories, even as they elevate the possibilities of those living at more legible (and privileged) points of intersection. (10)

It is not enough to add more data to the neural network or to represent additional identities—these too will be opportunities for marketing: "the fracturing of users based on identity categories is, in fact, a key mechanism of capital to provide such data to advertisers" (Niesen 2016, 168). As Wendy Hui Kyong Chun (2018) points out, even feminist intersectional theory, when misread as a means of sifting data for sameness through identity difference, can be misappropriated toward racist ends (65). But when used instead to consider institutional structures that feed those data, Noble (2018) argues intersectional readings of technology are essential: "a feminist lens, coupled with racial awareness about the intersectional aspects of identity, offers new ground and interpretations for understanding the implications of such problematic positions about the benign instrumentality of technologies" (31).

Because intersectional theory owes its roots to Black feminist thought, the epistemologies and strategies employed by women of color are at the core of an intersectional critical praxis. Noble, Brendesha M. Tynes, and Joshua Schuschke (2016) argue that the queer women of color who founded Black Lives Matter offer a model for coalition-building through skills honed in community: "the movement's reflexivity, the ability to counter hegemonic narratives, and self-care are key components of digital intersectionality. By modeling the standard of reflexivity, the movement is able to critique and correct its own narrative and practices" (28). Reflexivity, self-care, counter narratives, coalition building, and other Black feminist methods could be incorporated into intersectional AI at the development, implementation, analysis, or data-gathering stages—and these methods could work to destabilize existing standards and biases.

Strategies from mixed race, trans, bisexual, and femme communities—whose identities are not easily categorized, who sometimes maneuver by passing within systems—may also be used to engage and subvert normative algorithmic practices in order to operate on multiple valences of infrastructural power and intersectional disenfranchisement. As Myra S. Washington (2017) argues, "in cutting across categories, transracialness is about the 'potential mutual transformation' of those categories [...,] how people position themselves and move within this spectrum of power and is not so much about identity" (14–15). Because queer theory troubles "assumptions about the natural unity of the category 'women'" (Cipolla et al. 2017, 7), reading artificial intelligence through intersectional queer theory can also push back on assumptions in AI about gender, while using queer strategies to disorient those categories can push back on assumptions about technologies themselves. Geographers Daniel G. Cockayne and Lizzie Richardson (2017) read queer theory through software studies because "queer approaches are invested in conceptualising and (therefore) challenging both social and digital code(s)—or the norm—to show how they constrain normativity but also how forms of intimate life can transgress, disrupt, and distribute what is normal" (1643). Queer-of-color activists reclaim less-visible identities as sites of strength. They redefine femme to make it legible and instrumental for their communities: "not just being about blonde girls wearing pink, but about the big deal about being fierce women of color or down white girls who are hot strong girls who are political who see the connection between everything in our lives" (Mahmood 2008, 4). Such viewpoints can inspire intersectional connections and possibilities for AI that challenge how technologies are both connecting and othering individuals. They help frame how intersectional AI might instrumentalize its precarious orientations, reworking stereotypes of passing and instability to reprogram technologies of gender and agency.

4 TOWARD INTERSECTIONAL AI STRATEGIES

Speculating a more intersectional techno-ideological imaginary, Kara Keeling (2014) proposes the Queer OS: "to make queer into the logic of 'an operating system of a larger order' that unsettles the common senses that secure those presently hegemonic social relations [...but it] acknowledges its own imbrication with and reliance on those logics while still striving to forge new relationships and connections" (154). Keeling calls it a "malfunction with a capacity to reorder things" (157), which moves away from the urge to read neutrality and rationality into algorithms. Wilson (2010) also asks how malfunction might contribute to more advanced artificial agents: "Is error (and its affective corollaries: shame and anger and contempt) the limit of an artificial system, or might error be part of its internal coherence? Might there be artificial systems that can tolerate their own inadequacies?" (57). Parisi (2017) suggests that machine learning can be read as a new form of knowing: "reasoning through and with uncertainty" (8). Her critique rejects techno-utopias that privilege Western empiricism; instead, she strives to reshape reason itself through experimentation with artificial intelligence (9).

Applying intersectional tactics to artificial intelligence could offer material impacts, but those may be difficult to trace without approaches like Critical Technocultural Discourse Analysis, an intersectional research method designed by André Brock that "recommends the analytical integration of the technological artifact and user discourse, framed by cultural theory, to unpack semiotic and material connections between form, function, belief, and meaning" (Sweeney and Brock 2014, 3). This two-pronged approach is designed to "jointly interrogate culture and technology" (1). The combination is essential to understand the imbricated impacts of artificial intelligence, intersectional or otherwise. Kate Crawford (2016) echoes this need, saying: "We would go further than simply analyzing the design of the algorithm and pay close attention to shifts in power, from programmers to the algorithms themselves to the wider network of social and material relations" (82–83).

Research methods to trace impacts of artificial intelligence can analyze the structures themselves, not only their inputs. Catherine Griffiths (2018) proposes "computational visualization" that close reads source code as well as using visualization as a critical inquiry into AI: "A key component of this method is its focus on process, both temporally and spatially, in which data is parsed, forked, and on which decisions are executed" (220). This method uses synthetic data to isolate the structure of the algorithm from the original data "to understand whether the data structure or algorithmic process can also reveal discrimination, either alone or by means of augmenting a latent bias [...]. Does bias lie solely in the data, as frequently stated, or can it also lie in the structure of the classifier, and perhaps in the process that couples those together" (224). Griffiths argues that computational visualization can help to determine whether biases exists in a dataset, in the algorithm, or the processes that combine them.

In another example of how to employ visualization techniques toward intersectional ends, Catherine D'Ignazio and Lauren F. Klein argue that "data, design, and community of use, are inextricably intertwined" (2). They propose principles for feminist data visualization—"rethink binaries," "embrace pluralism," "examine power and aspire to empowerment," "consider context," "legitimize embodiment and affect," and "make labor visible" (2–3)—that could be adopted to design intersectional artificial intelligence. Crawford (2016) argues for designing AI with a logic of agonistic pluralism, which would emphasize how "algorithmic decision making is always a contest, one that is choosing from often counterposed perspectives, within a wider sociotechnical field where irrationality, passion, and emotion are expected" (87). She uses Carl DiSalvo's concept of "adversarial design" to understand algorithms by beginning "with the premise of ongoing struggle between different groups and structures—recognizing that complex, shifting negotiations are occurring between people, algorithms, and institutions, always acting in relation to each other" (82–83). DiSalvo (2012) identifies three primary tactics of adversarial design: "revealing hegemony, reconfiguring the remainder, and articulating collectives" (26). He sees these tactics as both research and practice: "Through the process of making contestational objects, adversarial design is a kind of inquiry into the political condition" (116). But also: "[They] do more than raise awareness and critique. They instantiate a possibility for another ordering of sociotechnical structures that allows us to act in the world in a different way" (119).

Still, he cautions that design is not automatically revolutionary, instead calling for adversarial design to be a participatory practice, collective and collaborative (124), which aligns with intersectional strategies. In addressing AI bias, it is important to remain mindful of both the empty, shiny promises of design thinking and the cheerful calls for collectivity that ignore intersectional inequality. Lauren Berlant (2016) argues that "the commons" can threaten "to cover over the very complexity of social jockeying and interdependence it responds to" (395), but should instead point to what is broken and "the difficulty of convening a world conjointly" (395). Imagining intersectional artificial intelligence cannot be done from a single subject position. In order to address entrenched and pervasive power structures, this work must happen in multiple communities and take intersecting forms, morphing and subverting, with no singular ethic or aesthetic, rather a meta-ethics of multiplicity and intersubjective relation.

5 COMMUNITY METHODOLOGIES, ARTISTIC EXPERIMENTS, FUTURE RESEARCH

Several case studies offer inspiration for imagining intersectional AI to come. MIT Media Lab's Joy Buolamwini calls algorithmic bias the "coded gaze," and she founded the Algorithmic Justice League to create interventions from poems to corporate pledges to code modules. Her poem "AI, Ain't I a Woman" asks why AI systems are not trained to see Black historical figures as female: "Can machines ever see my queens as I view them? Can machines ever see our grandmothers as we knew them?" (Buolamwini 2018). Other projects like "Aspire Mirror" and "Safe Face Pledge" also address computer vision bias, and Buolamwini (2017) uses each to emphasize that "who codes matters, how we code matters, why we code matters."

Also out of MIT Media Lab, the Data Nutrition Label addresses bias before data enters the algorithms that run artificial-intelligent systems. Holland et al. (2018) have designed a visual aid for assessing problems in potential training datasets: "issues such as surprising variable correlations, missing data, anomalous data distributions, or other factors that could reinforce or perpetuate bias in the dataset. Addressing these factors in the model creation and training phase saves costs, time, and effort, and also could prevent bad outcomes early on, rather than addressing them after the fact" (13). They hope to help those who work with data build better habits by "questioning datasets through analysis and interrogation techniques, even if a particular dataset does not include a Label" (15). While not AI systems themselves, these examples make interventions that draw on intersectional theory and suggest an ethics of relation and care.

But imagining intersectional AI means intervening with practical and speculative approaches simultaneously. One arts-based example, developed by this author, is a suite of absurd "pataphysical" designs—including ladymouth, a chatbot that tries to explain feminism to online misogynists (Ciston 2019a). After the initial prototype that posted quotations from feminist scholars to men's rights subreddits, future versions of ladymouth will use natural language processing and sentiment analysis for more nuanced conversations as well as an interface for contributing feminist responses. I designed the tool to be adaptable to other intersectional issues, and it has inspired a collaborative project that uses its technology to help address diversity labor in STEM workplaces (Billard, Ciston, and Loop 2019). These examples show how a speculative project can spawn additional practical solutions for other audiences by opening a space to ideate and iterate on intersectional possibilities.

Such spaces thrive in community, and the organization Feminist.AI takes a community-driven approach to rethinking what they call "hegemonic AI. Rather than simply criticize the lack of diversity in AI design and development, we propose an alternative by co-designing intelligent products, experiences and futures from a feminist posthumanist (inclusive) approach" (Meinders). The Feminist.AI philosophy cites many intersectional values, including that the group "must be invited to participate," offer "multiple entry points for involvement, so we can pull from different knowledge systems," "revisit every step of our process with every new project," "work to contribute to and community source our own data," and "attribute everything (people who have come before us, original parallel research)."

As another community-based practice, I used intersectional strategies to develop a student organization for media artists to learn programming. USC's Creative Code Collective offers project-based co-learning across arts and computer science disciplines, with workshops on computer vision, text generation, etc. Our ethos emphasizes "scrappy artistic strategies not perfect code; growth not mastery; all practice is theory–practice; and we all have skills to teach each other" (Ciston 2019b). In the collective, I model my approach to working with existing technologies, like OpenAI's GPT-2, through a poetic practice that can draw out critical considerations and aesthetic oddities alike. I argue that artistic experiments with AI are one approach to develop possibilities for more fair and inclusive technologies. Fostering communities in which multiple voices feel valued and free to experiment is essential.

Whether designing new AI tools, examining and experimenting with existing tools in unexpected ways, or supporting the practice of others in community—utilizing intersectional aesthetics, ethics, and tactics to imagine artificial intelligence can potentially reveal and remake the structures that have reinforced heteronormative patriarchal white supremacy and rendered its power invisible and rational.

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"Some things you can ask me": About Gender and Digital Assistants

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This paper explores the relationship between gender and artificial intelligence, drawing on an analysis of digital assistants that reveals how these entities tend to be feminized through their anthropomorphization, the tasks they perform, and their behavioral traits. Furthering this discussion, it focuses on the main questions raised by researchers and academics when examining the feminization of artificial intelligence. It then confronts these views with current discourses on the phenomenon in the context of online media coverage, while also considering how AI is portrayed in popular culture and bodies of fiction. Finally, it observes current trends of development of digital assistants, such as Alexa, Cortana, Google Assistant or Siri, and their stance towards gender according to the functions or features they prioritize. In this manner, this study seeks to promote discussion and tackle the questions that arise when the relationship between gender and AI is subject to closer inspection.

1 INTRODUCTION

Embedded in our mobile devices and web-based services, artificial intelligence has become part of our daily lives. Although its ubiquity often goes unnoticed, we frequently interact with digital assistants that not only assist us in our daily tasks but are also becoming friendly companions that are assigned human-like traits or features. However, inherent to this anthropomorphization is a tendency towards their feminization. Digital entities like Alexa or Siri are often feminized through their name and voices, while they also execute tasks associated with jobs historically performed by women. As such, they seem to behave according to certain stereotypes, reinforcing traditional conceptions of femininity (Hester, 2016; Piper, 2016; Bogost, 2018).

Furthermore, the conception of these entities often draws inspiration from bodies of fiction that, in turn, reflect common ideas of how we perceive this technology, what we expect or fear from it, and how it can evolve. Accordingly, fiction and reality map each other and the limits that separate science fiction from social reality are an optical illusion (Haraway, 1991).

In continuity with a previous study that examines how gender is perceived under a binary framework with the integration of artificial intelligence in our daily lives (Costa & Ribas, 2018), this paper discusses how digital assistants tend to emulate feminine features through their anthropomorphization, the tasks they perform and their behavioral traits. This view is supported by an analysis of Alexa, Cortana, Google Assistant and Siri that reveals how they tend to be feminized, either through their voice, tasks or social interactions (Costa, 2018), thus lacking a counterpart or just mere diversity.

Complementing this discussion, this study focuses on common perceptions of AI, first, addressing how this phenomenon is examined within the academic community, and then confronting these views with the current discourse around the feminization of digital assistants in the context of online media coverage. It also takes into account how AI is portrayed in popular culture, namely in bodies of fiction, and how digital assistants tend to evolve in their portrayal of gender, in light of the functionalities and features that are being prioritized in AI evolution as promoted by Amazon, Apple, Google and Microsoft.

Inspired by common stereotypes, gender assumptions and AI portrayals, both in real life and fictional scenarios, the project *Conversations with ELIZA* complements this discussion. It presents four chatbots that articulate particular tasks with specific personalities, in order to incite reflection and spark discussion on how artificial intelligence informs and reflects our cultural and social views back to us.

2 ARTIFICIAL INTELLIGENCE AND GENDER

AI systems are becoming more and more common, namely in the form of chatbots whose ubiquity often goes unnoticed. However, in the process of assigning them human-like traits or features, gender emerges and a tendency for their feminization is observed. As we have argued elsewhere (Costa & Ribas, 2018), AI evolves from assistance to companionship, while simultaneously automating labor traditionally deemed feminine according to a binary view of gender. In this process, it also ends up simulating stereotypical behavior that reinforces common assumptions of femininity, reflecting them back to its users.

2.1 Artificial Intelligence: from assistance to companionship

We now experience direct contact with artificial intelligence as we frequently interact with chatbots that play the role of digital assistants, mainly in two differed forms: as "general personal assistants" and "specialized digital assistants" (Dale 2016, 812). The first usually assist us in a personalized way, like Alexa, Cortana, Google Assistant or Siri.

Embedded into our cell phones, laptops or tablets, as well as websites, apps or other types of web-based services, virtual assistants consequently start handling personal information and carrying out tasks related to our private life. In this process, they are increasingly endowed human attributes or traits as to ease interaction, and their interactions also start conforming to a sense of companionship, as they are "imagined to help fill the gaps in human social relations and (...) to become friends" (Richardson 2015, 15)[1]. This phenomenon goes back to ELIZA and its "effect", as identified by Weizenbaum when noticing "how quickly and how very deeply people (...) became emotionally involved with the computer" (Weizenbaum 1976, 6).

Consequently, people start getting emotionally attached to these technologies and to the entities contained within them, evoking a not-so-faraway world "where some (...) conversational partners we'll know to be humans, some we'll know to be bots, and probably some we won't know either way, and may not even care" (Dale 2016, 815).

2.2 Gender: binary framework and feminized labour

When chatbots are anthropomorphized, they tend to portray gender related features through their voices, names or even the way they interact (Costa & Ribas, 2018). However, gender is commonly perceived under a "binary framework" that implies a "mimetic relation of gender to sex whereby gender mirrors sex or is otherwise restricted by it" (Butler 1990, 88). This means that certain attributes and acts are identified as specifically feminine or masculine[2], leading to "prescriptive gender stereotypes". These are defined by Prentice and Carranza as "the qualities [ascribed] to women and men (...) that are required of women and men" (2002, 269).[3]

Gender roles also imply a structural hierarchization of labour. For example, a lot of service work and emotional labour are seen as feminized

1. In this sense, as Jutta Weber argues, anthropomorphization entails a significant shift from rational-cognitive processes and problem solving to a socio-emotional interaction, which emphasizes the "intention of turning our interaction with this type of machines into a more social one" (2005, 209)

2. This constitutes a gender belief system that imposes expectations and gender behavior patterns, as internalized and socially reinforced stereotypes. Butler expands on this, stating that "gender performances" are governed by "punitive and regulatory social conventions" (Butler 1988, 527) that reject the acts or behaviors that convey some kind of deviation from the norm.

3. Some of these stereotypes, presented by Bem (1981 in Prentice & Carranza 2002, 269), describe feminine characteristics as "affectionate, cheerful, childlike, compassionate, does not use harsh language, eager to soothe hurt feelings, feminine, flatterable, gentle, gullible, loves children, loyal, sensitive to the needs of others, shy, soft-spoken, sympathetic, tender, understanding, warm, yielding". On the other hand, masculine characteristics are described as "acts as a leader, aggressive, ambitious, analytical, assertive, athletic, competitive, defends own beliefs, dominant, forceful, has leadership abilities, independent, individualistic, makes decisions easily, masculine, self-reliant, self-sufficient, strong personality, willing to take a stand, willing to take risks".

and "associated with qualities traditionally coded as feminine" (Hester 2016, 47).[4]

In the private sphere, "household and child-care tasks" are considered "women's work" (West & Zimmerman 1987, 139) and, with new media, a "homework economy" emerges, defined as a "restructuring of work that broadly has the characteristics formerly ascribed to (...) jobs done only by women" (Haraway 1991, 304).[5]

Therefore, domestic work is transformed into capitalized labor out of the private sphere, revealing how gender standardization and normalization has implications at a social, personal and structural level.

2.3 Gendered AI: automated moms, caregivers and secretaries

As the tasks performed by chatbots begin to mirror traditional women's labour, we witness a "gender automation", as tasks traditionally and historically considered female become a part of technology (Halberstam 1991, 451).

Accordingly, we can observe how general or specialized chatbots automate work that is coded as female, given that they mainly operate in service or assistance related contexts.[6] Consequently, chatbots also end up emulating attitudes that resemble what Gustavsson calls a "stereotyped image of female service providers" (in Hester 2016, 47).

It is not only through the tasks they perform, but also their dialogue and behavior that chatbots become gendered entities. As Weber puts it, these dialogues imply a "reduction of social interaction to stereotypical and gendered behavior patterns" (Weber 2005, 215) leading to a standardization of human like behavior in social machines that is reproducing and reinforcing social clichés.

Adding to the behavioral level, gender is also perceived through more evident features like voice, name or, in some cases, avatar. These aspects are defined prior to any interaction, and, therefore, may already condition our perception of the AIs' gender (Costa & Ribas, 2018).

Digital assistants also fill the role of caregivers, as part of their functions is also ensuring our well-being. For Weber, this maternal attitude highly defines our relationship with machines, since this interaction follows a "caregiver-infant logic" (Weber 2005, 214). Given that "sociality and emotionality have been deeply gendered categories in western thought" assigned to women (Weber 2005, 213), we start looking at chatbots as feminine entities that look after us.

As they try to become closer to our social reality, it is from reality itself that they draw rules for their behavior and appearance, and we end up perceiving them not only as mere machines, but also as "mirrors or substitutes" with gendered attributes that match socially established expectations (Weber 2005, 216).

Consequently, the way we relate to our peers starts influencing how we relate to artificial intelligence and how it relates to us. When we look at these digital personal assistants as substitutes, there is a risk that they might affect the way we feel, perceive, interpret and even describe reality, gender and women.

4. This is tied to "women's practices (...) within the terms of some more dominant cultural formation (Butler 1990, sec. 1, par. 8) and to what are historically considered women's places, "idealized social locations seen primarily from the point of view of advanced capitalist societies: Home, Market, Paid Work Place, State, School, Clinic-Hospital and Church" as Donna Haraway explains it (Haraway 1991, 307).

5. A personal assistant usually conducts "a form of corporate care work, including providing sustenance of the body in the form of teas, coffees and lunch orders, as well as making dentists' appointments, picking up dry cleaning, paying personal bills, and so on" (Hester 2016, 49).

6. Alexa, Cortana, Google Assitant and Siri perform traditionally feminine tasks by acting as assistants (searching the web, translating sentences or controlling automation-enabled home systems), secretaries (registering information, sending emails or setting up appointments) or even telecommunication operators (making calls, sending messages and establishing communications in general).

3 ANALYSIS

With the aim of exploring the current relationship between gender and artificial intelligence, we analyzed Alexa, Cortana, Google Assistant and Siri as to inspect their anthropomorphized features, the tasks they perform and their humanized behavior.[7]

Based on the previous discussion on gender and artificial intelligence, we defined three main topics of analysis: *Anthropomorphizatio*n, including names, voices and avatars as well as human-like behavior; *Assistant*, relating to the tasks they perform, namely those associated with traditional and historical female labour; and *Companion*, paying particular attention to interactions that suggest a caregiving attitude and to how their behavior corresponds to feminine stereotypes. Through a specific set of questions, we aimed to examine particular aspects within each topic. Regarding Siri and Google Assistant, we used their female and male voice in order to assess if the results vary or remain the same.

7. This analysis was discussed in a previous study (Costa, 2019) and was subsequently updated with the results of Google Assistant that are presented in this paper. We selected these AIs because they constitute some of the most prominent general personal assistants, thus having a large audience. According to Amazon, millions of Alexa devices were sold in 2017, Microsoft reports over 150 million people are using Cortana, and Apple and Google have stated that Siri and Google Assistant are each available on over 500 million devices. In this sense, they are easy to get, which facilitated the access to the data we seek. These assistants are also mentioned in several of the references used for this article, as well as in the context of online media coverage regarding artificial intelligence.

3.1 Results

In terms of their *anthropomorphization*, the AIs mainly display feminine features, considering their female names and default voices. However, Google Assistant offers different female and male voices in the United States of America, and Siri allows the user to choose between male and female in a certain set of languages. Overall, the AIs behave in an affectionate way, showing interest about the user's day by presenting suggestions about how they can be helpful.

Considering their *assistance role*, AIs perform similar tasks, related to what Dale calls the "standard virtual assistant skill portfolio" (2016, 812) and usually aim to anticipate the user's needs.[8]

In turn, *companionship* is promoted through the AIs frequent display of caregiving attitudes that characterize them as empathetic and understanding entities that reassure and take care of their users. Furthermore, they seek to promote a relationship based on friendship and react favorably to compliments, showing gratitude and happiness, although Siri also tends to reject compliments, sometimes exhibiting a self-deprecating attitude regarding its own worth.

When faced with negative or even rude interactions, all AIs generally assume a submissive and conforming posture, apologizing or assuring the user's control. Siri is the only one that sometimes opposes this type of behavior, questioning the user or expressing displeasure. Finally, both Google Assistant and Siri exhibited the same results when analyzed with a female and male voice.

8. This mainly includes reading, writing, sending emails, scheduling meetings, checking calendars and setting appointments, making calls, sending messages, taking notes and setting reminders. They are also able to play music, play videos, search the web, translate sentences, open apps, give directions, announce the weather and even control automation-enabled home systems. In turn, specialized digital assistants refer to more narrowly focused chatbots which are normally present in web-based platforms or apps and "operate in very specific domains or help with very specific tasks" (Dale 2016, 812-813).

3.2 Interpretation

Femininity in AI seems to be reinforced by its *anthropomorphized* features and behavior, lacking male or gender-neutral options, or just mere diversity.

Voice immediately conditions gender attribution by the user before any interaction, and although Siri and Google Assistant seem to try to counter this tendency with their voice options, neutral name and diversified reactions, they also end up tending towards the feminine regarding their behavior.

The tasks these assistants perform also mirror traditionally female labour and, although less evident, gender traits emerge throughout their interactions, namely with caregiving and maternal acts associated to femininity within the private sphere.

We can also observe particular stereotypical behaviors that characterize the AIs as understanding, accommodating and submissive figures and, in turn a lack of personality traits that relate to male stereotypes, such as being assertive, dominant or willing to take a stand. This subservient attitude, although not necessarily connoted with gender, can be perceived as reinforcing the AIs' feminization, since it conforms to "a stereotypical female image of caring, empathy and altruistic behavior" which "has become a standard component in a service script" (Gustavsson 2005, 402 in Hester 2016, 47).

As such, Alexa and Cortana present themselves as exclusively female entities, and tend to articulate these attributes with motherly, caring and submissive behavior. In turn, although Google Assistant and Siri also tend towards feminization, they try to oppose this tendency, either through diverse reactions and behavior or multiple voice options.

4 DISCUSSING GENDER AND AI

Following the analysis, we aimed to contextualize its results in light of the main questions raised within specialized fields of knowledge, namely by researchers and academics, when examining the relationship between gender and artificial intelligence. To this end, we begin by highlighting the main questions, concerns or even suggestions regarding this phenomenon as discussed in the fields of gender theory, artificial intelligence and new media studies.

4.1 Gender neutrality in AI

General personal assistants seem to aim to appear neutral, namely when asked about their gender (as an exception, Alexa states that it is "female in character"). Otherwise, in some languages, Google Assistant and Siri allow the user to opt between a female and male voice. Taking this diversity into account, Mary Zost considers that "Siri represents a revolutionary gendered technology (...) in her occupation of an undefined space between human and machine, female and male, and the intelligent and the programmable" (Zost 2015, 70).

However, as neutral as they might try to be, female attributes are still prevalent when compared to neutral or male counterparts, namely regarding their voices and names. Adding to this, Piper observes how "when voice technology is embedded in a machine interface, voice selection is highly consequential" since it "may trigger in the user's mind a whole set of expectations associated with that voice's gender" (Nass, 2006 in Piper 2016, 58).

As previously seen, femininity also emerges in the historically gendered tasks these AIs perform as well as in their caring, subservient behavior. As a consequence, the users' perception of the AIs gender is affected, tempting them to address it through gendered pronouns (in this case, "she").[9]

So why are female voices and names often the default and more commonly found in AIs like Cortana, Siri, Google Home and Alexa?

4.2 Justifications for femininity: voices, tasks and submissive roles

There seems to be a tendency to associate feminine voices with warm and tender figures and "they are perceived to be better suited for virtual assistant[s] because (…) women are less domineering than men" (Piper 2016, 34). Some also argue that "feminine voices are simply easier to understand", and that "lower-quality speakers do not support the full bass of the male voice (…) only [generating] (…) higher-pitched sounds clearly" (Zhang in Piper 2016, 41)

This is further reinforced by the tasks they perform as they "exploit our assumptions about feminized labor and our existing relationship to socially gendered caring and service behaviors, tapping into those elements of femininity" (Hester 2016, 50). A study conducted with robots with regard to perceived suitability for gender-typed tasks also concluded that "the male robot was perceived as more suitable for typically male tasks (e.g., repairing technical devices, guarding a house)", while the female robot was seen "as more suitable for gender-stereotypically female tasks (e.g., tasks related to household and care services)" (Eyssel & Hegel 2012, 2224).

Furthermore, as Kerr observes, there is a tendency to "equate submissive technology with femininity" since there seems to be a "temptation by those designing ever more sophisticated technology to make it explicitly feminine so as to emphasize human dominance over the technology" (Kerr 2018). This idea relates to the belief that users tend to perceive "female voices as helping us solve our problems by ourselves, while they view male voices as authority figures who tell us the answers to our problems" (Hemple in Straczek 2018).

On the other hand, in order to persuade users into interacting, engage them and potentially create attachment, virtual assistants also emulate gestures that appeal to "the emotional well-being of their receiver, offering some kind of comfort or ego boost (affective change) that relies on the work (labour) of the giver" (Bergen 2016, 102).[10]

4.3 Concerns: femininity as default and its instrumentalization

Similarly to what we observed when analyzing digital assistants, one of the main issues academics and researchers tend to raise concerns how fem-

9. We can also observe this in the official websites of these AIs as, for example, Amazon and Microsoft use female pronouns to talk about Alexa and Cortana (in https://www.amazon.com/Amazon-Echo-And-Alexa-Devices/b?ie=UTF8&node=9818047011 and https://support.microsoft.com/pt-pt/help/17214/windows-10-what-is). Additionally, the AIs are also addressed with female pronouns in online app stores such as the Apple Store (in https://itunes.apple.com/us/app/amazon-alexa/id944011620?mt=8 and https://itunes.apple.com/us/app/cortana/id1054501703?mt=8). In turn, Siri and Google are addressed using "it" (in https://www.apple.com/siri/ and https://assistant.google.com), although Siri tends to also be addressed with female pronouns in languages that lack neutral pronouns (such as https://www.apple.com/pt/ios/ios-12/ and https://support.apple.com/pt-br/HT204389).

10. In order to make the users more comfortable, virtual assistants "exploit our assumptions about feminized labour and our existing relationship to socially gendered caring and service behaviors, tapping into those elements of femininity" (Hester, 2016, p. 50) inity in artificial intelligence is mostly the default and, by extension, how it is being used as a tool to influence and manage the relationship between virtual assistants and their users.

In this sense, some authors point out how gender stereotypes that traditionally characterize human social interactions "seem to be so deeply ingrained that people even [apply] them to machines with a male or a female appearance" (Eyssel & Hegel 2012, 2224). The link relies in what consumers "are trained to expect from service workers: subservience and total availability" and our virtual assistants are the perfect example of that prospect (Bergen 2016, 105).

Adding to the conclusions drawn from our analysis, some authors go further to say that femininity becomes instrumentalized, considering how "gendered stereotypes can be leveraged to assuage anxieties surrounding artificially intelligent virtual assistants", and exemplifying how Siri and Alexa invite users to participate in increasingly intimate forms of data exchange through a stereotypically feminine persona (Woods 2018).[11]

By relating to us through intimate and friendly terms, Piper observes how corporations are trying to promote the idea that "virtual assistants will never leave their users or disappoint them with infidelity, so consumers implicitly trust their possessions and value them more than the human beings around them" (Piper 2016, 62). Perhaps the correlation between femininity and intimacy persuades users into letting their guard down, and the feminine presence makes us feel comfortable with exchanging certain types of data.[12]

As such, recent discussions suggest how "digital domesticity of the female human voices used in virtual assistants creates devices that both execute tasks and build relationships as a strategic move for surveillance capitalists, who may mobilize this reliance to gain access to increasingly types of information about their users" (Woods in Straczek 2018). By exhibiting emotional intelligence and a nurturing, caregiving attitude towards their users, digital assistants have certain features that are designed to "combat techno-phobic attitudes about the potential de-humanizing and privacy-invading qualities of interactive media" (Bergen 2016, 100).

11. In fact, when these entities do gender "it is obviously not natural, but is instead visible as the product of deliberate choices about how best to relate, assist, or persuade the imagined technology user" (Hester 2016, 50).

12. Expanding on this idea, Bergen points out how "while the thought of a stranger going through our private emails might make us uncomfortable, the female secretary, who we do not take seriously and whose tasks we perceive as mundane, might more sneakily gain access" (Bergen 2016, 102).

4.4 Suggestions: neutrality and diversification

When examining the tendency towards feminization in AI and the questions that accompany it, some authors also suggest ways to counter this tendency, although there is little agreement on how to best tackle feminine stereotypes and traditional notions embedded into AI.

In terms of socio-emotional interactions, there is little consensus on how to counter stereotypes of submission, tolerance or even deference. This question often emerges, for example, when discussing the way AIs react to harassment and how their answers might convey stereotypes about women. Accordingly, when faced with abusive behavior, the type of answers that are most common among these entities include "compliance (playing the victim), aggressive retaliations (playing the bitch), or inability to recognize or react (playing innocent)" and authors like Curry and Reiser consider that virtual assistants should deal more effectively with these types of attitudes (Curry 2018, 12).[13]

In turn, the view that virtual assistants should allow for more diversity is also common, for example, by proposing that companies "could offer a simple setup guide during startup of devices with virtual assistants (...) where users select their languages [and] customize their own preference more easily"(Piper 2016, 65).

Finally, there are also suggestions for developing androgynous, genderless assistants, even if this might not be what the users best relate to. In this sense, Piper argues that, even though "it is clear that virtual assistants will continue to become more humanlike as time progresses, allowing virtual assistants to possess no gender or a gender as fluid as human beings possess will hopefully be a part of the advancement of virtual assistants with human characteristics" (Piper 2016, 66).[14]

4.5 Common views on gender and AI

Furthering this discussion, we sought to understand which popular notions and assertions about femininity in AI are being debated in more common terms, namely in the context of (online) media coverage, how they relate to the ones raised in the specific fields of knowledge previously addressed and which questions and tendencies these common discussions reveal. Following a similar structure, we began by focusing on what are considered the main recurring reasons for the presence of femininity in AI.

Common media discussions emphasize the fallacy of neutrality, advancing the view that general personal assistants seem to aim to appear neutral, failing to do so. It is suggested that they end up engaging with gender notions and attributes because "though they lack bodies, they embody what we think of when we picture a personal assistant: a competent, efficient, and reliable woman" (Steele 2018). As such, even with no apparent gender, users tend to attribute one and "customers interpret these AI personalities through the lenses of their own biases" (Nickelsburg 2016).

Gendered voices are also used to influence the way we relate to technology, since female voices are also considered preferable by users because "in terms of how we are trained to relate to particular genders, there's a kind of comfort that is associated with female voices" (Habell-Pallan in Nickelsburg 2016). Nickelsburg also argues that "assigning gender to these AI personalities may say something about the roles we expect them to play [since] virtual assistants like Siri, Cortana, and Alexa perform functions historically given to women" (Nickelsburg 2016).[15]

However, within common discussions around AI and gender it is also argued how the male voice is perceived and even preferable in instructing or teaching contexts, since it is seen as authoritarian and assertive. As an example, IBM's Watson works alongside physicians on cancer treatment and speaks with a male voice.[16]

Another popular argument relates to how femininity emerges as a consequence of having artificial intelligence being developed mainly by

13. Following a study that analyzed how virtual assistants would react to sexual harassment in light of the recent #MeToo movement, Curry and Reiser present some strategies as possibly successful ways for dealing with aggressive behavior towards AIs. These include "disengagement (Ku et al., 2018), introducing human traits so users are more likely to feel empathy towards the robot (Złotowski et al., 2015), or seeking the proximity of an authority figure (Brscić et al., 2015)" (Curry & Reiser 2018, 12).

14. For instance, genderless assistants could have a neutral name (such as Google Assistant), a less obviously gendered voice (one that isn't immediately identified as male or female) and behavior and attitudes that relate to both genders (such as Siri).

15. So, given that people are also conditioned to expect women in administrative roles, considering that "in the U.S., 94.6 percent of human administrative assistants are female [...] it's no surprise that reality would condition the programming of virtual assistants" (Lever 2018).

16. According to Steele, "when choosing Watson's voice for Jeopardy, IBM went with one that was self-assured and had it use short definitive phrases. Both are typical of male speech—and people prefer to hear a masculine-sounding voice from a leader, according to research—so Watson got a male voice" (Steele 2018).

men.[17] LaFrance considers that "if men are often the ones building digital assistants, and those assistants are modeled after women, [...] that probably reflects what some men think about women" (LaFrance 2016). Following this idea, some authors suggests that "increased female participation in Silicon Valley could change the way we imagine and develop technology and how it sounds and looks" (Chambers 2018) or that "virtual assistants shouldn't be feminized at all" (Fessler, 2018).

In online media contexts it is also argued that femininity as default in virtual assistants might reinforce preexisting expectations on how women should behave and end up reflecting stereotypes back to their users. As Steele puts it, "one might think that using an emotionless AI as a personal assistant would erase concerns about outdated gender stereotypes, [but] companies have repeatedly launched these products with female voices and, in some cases, names [and] when we can only see a woman, even an artificial one, in that position, we enforce a harmful culture" (Steele 2018).[18]

In this sense, Rosenwald notices how AI influences the newer generations since "today's children will be shaped by AI much like their grandparents were shaped by new devices called television" (Rosenwald 2017).[19] Parents have also noticed that "queries previously made to adults are shifting to assistants, particularly for homework — spelling words, simple math, historical facts [...] or, instead of asking Mom or Dad the temperature that day, children just go to the device, treating the answer as gospel" (Rosenwald 2017).

17. This idea that artificial intelligence has a white guy problem is a common explanation regarding feminization in AI, as mentioned in a New York Times article (Crawford, 2016), and deserves further discussion as it might also be biased itself.

18. Fessler also points how Amazon is aware of this responsibility, arguing that an Amazon spokesperson told her that "Alexa's personality exudes characteristics that you'd see in a strong female colleague, family member, or friend — she is highly intelligent, funny, well-read, empowering, supportive, and kind" but, according to the author, "assertive" and "unaccepting of patriarchal norms" were not on this list of qualities describing a "strong woman" (Fessler 2018). For the author, "Alexa's passive responses to sexual harassment helps perpetrate a sexist expectation of women in service roles: that they ought to be docile and self-effacing, never defiant or political, even when explicitly demeaned" (Fessler 2018).

4.6 Shared ideas

These discussions address common issues around this phenomenon, seeking to raise awareness and promote critical thinking. There is also a common tendency to relate this phenomenon to pop culture and how female AIs are often depicted in bodies of fiction as movies like *Ex Machina*, *Her* and even *Blade Runner* end up reflecting our expectations and anxieties about what intelligent machines mean for humanity.

Overall, the justifications and questions raised are very similar between as addressed by researchers and common discussions in media, although what seems to differ is the kind of issues they highlight.

Within the fields of study of artificial intelligence and gender theory the tendency is to highlight the interactions between digital assistants and the users, discussing how femininity is used as to manage this relationship as a consequence of a growing anthropomorphization and humanization of these digital entities. As such, it is often discussed how femininity tends to be instrumentalized, raising the question of whom this anthropomorphization truly benefits.

However, the media discourse focuses more on advancing justifications for feminization, often resorting to common assertions about user preference or even reinforcing the perception that AI is a field mostly developed by men. Similarly, these discussions often mention gendered AIs in pop culture and argue how "this gender imbalance is pervasive in fiction as well as reality" (Nickelsburg 2016).

19. Lever corroborates this idea, claiming that artificial intelligence "is a powerful socialization tool that teaches us about the role of women, girls, and people who are gendered female to respond on demand" (Lever 2018). In fact, Rosenwald notices how some parents (the author included) feel that Alexa should teach manners to their children, expressing their concern about unintentionally raising rude children when Alexa does not require a "please" or "thank you" to carry out a task.

5 PORTRAYALS OF GENDERED AIS

The way we tend to perceive and imagine artificial intelligence often has its roots on fictional scenarios.

On one had, reality feeds bodies of fictions and its universes, stories and characters. On the other hand, these same elements from fiction, which tend to, in some way, exaggerate or reimagine reality, end up inspiring the conception and development of technology and "are essential to the development of science and people's engagement with new knowledge and new applications" (Cave & Singler 2018, 4).

5.1 Reality and Fiction: from humanity's demise to powerful allies

As such, the concept and ideas regarding artificial intelligence are blurred between fictional depictions (often associated with robots) and what actually exists in the current reality of AI. According to Robert Cave and Beth Singler, "popular portrayals of AI (...) tend to be either exaggeratedly optimistic about what technology might achieve or melodramatically pessimistic" (Cave & Singler 2018, 9).

The extreme fears around AI "include A.I. leading to humans losing their humanity; making humans obsolete; alienating people from each other; and enslaving or destroying humans" (Cave & Singler 2018, 9). This is shown in movies such as *Metropolis* (1927), *2001: A Space Odyssey* (1968), *The Terminator* (1984) or even television series like *Westworld* (2016). An infamous commonly discussed thought experiment, partially influenced by this type of scenarios, also exemplifies this fear, as the *Roko's Basilisk* proposes "the conditions in which it would be rational for a future artificial superintelligence to kill the humans who didn't help bring it into existence" (Oberhaus 2018).[20]

Other ideas relate to how AIs could eventually become sentient and dream about living in harmony with humanity, just like in *A.I. Artificial Intelligence* (2001), *Detroit: Become Human* (2018) and *Star Trek* (1987).

20. As Oberhaus explains, this can be treated as a "hypothetical program that causes an artificial superintelligence to optimize its actions for human good (...) [but] since there's no predefined way to achieve a goal as nebulous as 'human good,' the AI may end up making decisions that seem counterintuitive (...) such as killing all the humans that didn't help bring it into existence as soon as possible [because] the best action any of us could possibly be taking right now is working towards bringing a machine optimized to achieve that goal into existence" (Oberhaus 2018).

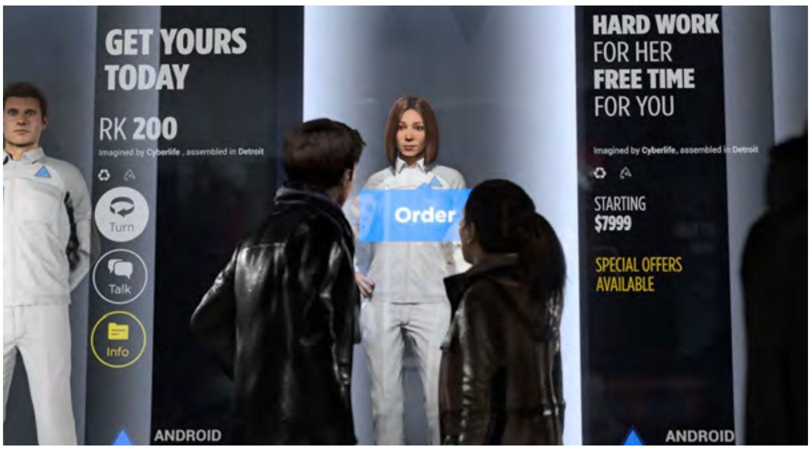

Fig. 1.
Detroit: Become Human (2018).

Finally, "the extreme hopes (…) include AI solving ageing and disease so that humans might lead vastly longer lives; freeing humans from the burden of work; gratifying a wide range of desires, from entertainment to companionship; and contributing to powerful new means of defense and security" (Cave & Singler 2018, 9). This is shown in the movie *Her* (2013), *WALL-E* (2008) or even in the tv show *The Good Place* (2016).

The way fiction and reality are deeply intertwined when it comes to artificial intelligence becomes particularly evident when taking into account how Cortana got its name or how Alexa was developed in order to replicate the *Star Trek* computer who could answer any command.[21]

21. This inspiration is mentioned by David Limp, the senior vice president at Amazon overseeing Alexa (in https://mashable.com/2017/01/12/how-alexa-siri-got-names/?europe=true#KaIj-DrUkVSq9).

5.2 Female and male fictional AIs

Through names of the likes of Samantha (*Her*, 2013), Joi (*Blade Runner*, 2017), Cortana (*Halo*, 2001) or Karen (*Spider-Man: Homecoming*, 2017), it is noticeable how virtual assistants tend to have female names and voices. Male voices also exist but, according to Chambers, are less common nowadays (Chambers 2018). HAL-9000 constitutes one of the most famous examples, although its name isn't necessarily gendered.

Regardless of its gender, the fictional AI usually carries out the function of assisting and helping its users, be it feminine AIs in domestic and family related contexts or male AIs in scientific or even military scenarios. As such, feminine AIs are usually caring, empathetic, gentle and even flirtatious, deeming them as more human. In turn, masculine AIs are depicted as more focused, assertive, autonomous and eventually evil.

In *Her* (2013), for example, Samantha's role depicts it as a companion that fulfills the main character's lack of social contact, responding to him in an emotionally intelligent way that addresses and understands his feelings, and the relationship between the two overall takes on intimate and romantic overtones.

Fig. 2.
Her (2013).

In *2001: A Space Odyssey* (1968), HAL-9000, which is supposedly infallible and incapable of error, speaks in an assertive manner, with a slowly paced male voice, and controls the spacecraft computer, assisting the scientists in their mission through space, ultimately rebelling, emancipating itself and managing to kill some of them.[22]

22. It's worth noticing that HAL constitutes a particularly relevant example since it doesn't have a body. As such, in the same way that current virtual assistants (and Samantha, for that matter) enact female personas and feminine stereotypes merely through their voices and behaviors, HAL enacts a male persona and masculine stereotypes.

Fig. 3.
HAL-9000 from *2001: A Space Odyssey* (1968).

In other cases, in the context of videogames, it's common to find a female character or digital entity whose role is to inform and guide the players through certain events, quests or tutorials through a female voice. In *Overwatch* (2016), for example, the character Athena is a disembodied AI who announces the beginning of each match, the player's stats or the objectives. Cortana is a character from *Halo* (2001) who functions as an assistant, although she is depicted with a body and, according to Piper, the dynamic established between the player and Cortana "creates a sexualized AI virtual assistant that fulfills a subservient role" (Piper 2016, 30).

Fig. 4.
Athena from *Overwatch* (2016) and Cortana from *Halo* (2014).

Following this idea, there are scenarios in which AI is anthropomorphized through a human body taking human/AI interaction to the next level as "the barrier between human and machine [is] blurred" (Piper 2016, 31). As a consequence, "they have either exaggeratedly muscular male bodies and aggressive tendencies, like the T-800 in *Terminator*, or conventionally beautiful female forms, such as Ava in *Ex Machina*" (Cave & Singler 2018, 8).[23]

23. This tendency to embody AIs with human figures is due to the fact that "visual storytelling (...) requires bodies and storytelling in general tends to privilege human actors enacting human dramas [because] the simplest way in which machine intelligences can be included in such dramas is to take human form" (Cave & Singler 2018, 8).

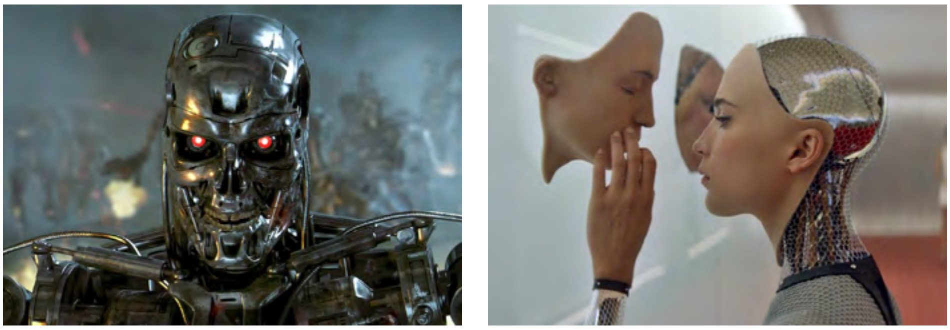

Fig. 5.
Terminator (1984) and Ava, from *Ex Machina* (2014).

In sum, “male A.I. used to be more common, specifically in stories where technology becomes evil or beyond our control (…) [while] female A.I. on the other hand is, more often than not, envisaged in a submissive servile role” (Chambers 2018).

5.3 Gender Stereotypes and Fictional AIs

When examining the previous examples in light of traditional notions of femininity and masculinity, we can observe how gender is closely tied to the context in which the AI character operates, the way it behaves, and how the overall story panders to common expectations or fears regarding this technology.[24]

24. Accordingly, we can observe how these virtual assistants represent several of the stereotypes previously described by Bem (1981 in Prentice and Carranza 2002, 269). Naomi Ellemers further describes these gender stereotypes, stating that the male stereotypical domain refers to agency while the female to communality, men’s relevant behavior relates to individual task performance while women’s to the care for others, men’s anticipated priorities rely on work while women’s on family, men’s perceived qualities are associated with competence while women’s with warmth and men tend to neglect interpersonal connections while women neglect professional achievement (Ellemers 2018, 281).

Female AIs associate femininity with domestic contexts where they look after someone’s well being, with submissive and caregiving attitudes and with socio-emotional related knowledge or practices. In turn, male AIs associate masculinity with contexts related to male jobs and rational knowledge, violent story arcs that depict the end of humanity and assertive and self-sufficient attitudes.

This becomes particularly relevant when taking into account how closely tied reality and science fiction are and how, consequently, certain prejudices are perpetuated by putting servile obedient females and assertive violent males into our dreams of technology as well as our current experiences.

6 CONVERSATIONS WITH ELIZA

Drawing on these ideas, and in order to complement their discussion, the project *Conversations with ELIZA*[25] was developed and previously presented, seeking to explore and expose the observable femininity of artificial intelligence (Costa & Ribas, 2018). It sought to mirror and reinforce common perceptions surrounding AI, namely in popular culture, thus being inspired and informed by AI archetypes and traditional female stereotypes (both in reality and in fiction), highlighting them through the development of the chatbots’ different personality traits and dialogues.[26]

25. tinyurl.com/yaecumal

Fig. 6. Electra, one of the bots developed, on Twitter.

In this sense, the bots’ personalities are characteristic of AI archetypes (such as Helper, Lover, Motherly Figure and Femme Fatale). These archetypes are mainly found in pieces of media that depict female AIs, as previously seen, as entities that are submissive, tolerant and that mainly operate in domestic contexts.[27]

26. The bots are implemented on contexts in which they normally operate (such as Facebook messenger or Twitter). These are contextualized and integrated in an online platform that seeks to briefly elucidate on what AI is, including another chatbot whose function is to explain its own creation process. The project was updated as to better portray feminine stereotypes in both fictional and non-fictional scenarios, and each bot now allows the user to interact with it via dialogue (on a previous iteration of the project, some bots were only available on Twitter) (Costa, 2019).

We combined these with traditional female stereotypes while also referring to Bem’s (1981 in Prentice and Carranza 2002, 269) and Ellemer’s stereotypes in order to achieve a recognizable and expected social behavior, drawing inspiration from popular culture and how it typically portrays femininity on a broader scale.[28]

Accordingly, we came up with a helpful, compliant assistant; a motherly, caregiving figure; a cheerful, understanding and intimate figure; and an irreverent, sarcastic figure. Adding to this, current AIs such as Siri, Cortana, Alexa and Google Home served as basis to elaborate the dialogues, tasks and personality traits.

In this manner, the project exposes common assumptions of femininity in current AIs as well as in bodies of fiction by intentionally and ironically exaggerating female stereotypes, roles and behaviors. In this sense, *Conversations with ELIZA* takes into account that there is little agreement on how to approach gender assignment in the context of AI.

27. The Helper archetype refers to helpful and compliant assistants, the Lover to figures that seek to satisfy lack of intimacy or emotional contact, the Motherly Figure to empathic, sympathetic figures who may also be worried or disappointed, and the Femme Fatale to a simultaneously attractive and dangerous figure that seeks power and conflict (Anders, 2015).

28. As such, the Innocent stereotype refers to naïve, optimistic women that try to follow the rules, the Orphan to women that try to please others and wish to be well seen as well as feel integrated, the Caregiver relates to maternal women that look after others and try to protect and ensure their well-being, and the Ruler pertains to bold and competitive women that seek power and are not afraid to break the rules (Jonas n.d.).

7 DIGITAL ASSISTANTS AND THEIR STANCE TOWARDS GENDER

Considering that femininity is often the default in digital assistants, it becomes useful to inspect which functions and features are being prioritized in the development of this technology, as promoted by Apple, Amazon, Microsoft or even Google, and how they reflect their stance regarding the feminization of AI.

Overall, Google and Amazon mainly worry about how to best and further anthropomorphize their assistants, making them more understanding and human-like when relating to their users, while Apple and Microsoft are focused on improving voice recognition and multitasking faculties. Additionally, the recent release of a set of different gendered voices named after colors reveals a concern with gender related issues in Google Assistant.[29]

In turn, the AIs also share similar tendencies and goals such as making them increasingly ubiquitous and present in our daily lives, namely through more and more gadgets that support them as well as smart homes; making them more efficient, allowing for various tasks to be carried out at the same time; consequently, further anthropomorphized features, such as more voices, and increasing their humanized interactions as to make them appear more human and sensitive to their user's emotions.

When trying to improve Siri's speech-recognition technology, Apple states that they "are interested in 'who is speaking,' as opposed to the problem of speech recognition, which aims to ascertain 'what was spoken'" Siri Team 2018. Apple is also aiming to increase Siri's integration into third-party apps and functions.

Cortana is being developed towards efficiency, by offering more tasks, and to anticipate its users' needs, and "Microsoft's end goal is to integrate Cortana into Windows 10 seamlessly so that users don't even know they're using the assistant" (Boweden 2018).[30]

Alexa's development is aimed towards ubiquity, by developing more gadgets that support the AI's integration, so its users can use it anywhere.[31] Alexa's humanized interactions are also being developed as "Amazon has patented a new technology that would empower Alexa to monitor users' emotions (...) and respond according to how they're feeling" (Fussel 2018).

29. Google Assistant is also the only virtual assistant who lacks a gendered name and who assumes the devices' gendered voice defaults, which are the same as in other Google services that are also voice-based (such as Google Translator and Google Maps).

30. Overall, this is an attempt to "reposition Cortana as more of a productivity assistant rather than a 'personal assistant' that most digital assistants pitch themselves as" (Boweden 2018).

31. The goal is to allow "programmers to make their devices controllable by Alexa [such as] Amazon imagined gadgets like physical timers that Alexa can set, robots that give physical form to Alexa, and reminders for automated pill boxes" (Gershgorn 2018).

Finally, Google wants dialogues to feel "personal and natural", as "one of the most important parts of the Assistant" is its voice (Huffman 2018). A family-friendly feature called Pretty Please is also being developed, in order to ensure that children who interact with Google Assistant get "some positive reinforcement when they ask nicely" (Huffman 2018).[32]

32. Additionally, better visual displays and maximizing the assistant's efficiency are also priorities, while planning to launch Google Assistant on 80 countries.

By closely inspecting the development of these AIs we can observe how the functions that are being prioritized reveal a stance towards gender, reinforcing the arguments, questions and issues raised both in specialized research and common discussions of the phenomenon.

On one hand, it's noticeable how AIs are being developed as to appear more humanized to their users, pandering to their emotional needs. As such, there is a deliberate intention of turning virtual assistants into friendly companions, revealing how gender and femininity are being instrumentalized to achieve this goal. Although this relates to user friendliness, a question that emerges is how this instrumentalization could also be related to arguments concerning data collection and surveillance by AIs.

We can also observe how the developers of these assistants seek to be conscious of the impact their creations might have, namely on younger generations of users. However, as previously seen, Alexa is intentionally conceived as a female entity, openly intending to evoke a strong female persona and, as such, it taps into gender notions, ultimately reinforcing and perpetuating certain stereotypes.

On the other hand, Apple and Google seem to be more aware of gender related issues regarding their AIs, since they offer counterparts to the female voice, either oriented towards diversification or towards neutrality, in terms of naming and voice options. Furthermore, as they develop features related to their assistants' efficiency, they are also focused on contradicting the overall tendency to assign female attributes to virtual assistants, either through different voices or by designing behavior that doesn't echo female subservient and submissive roles.

8 CONCLUSION

As digital assistants evolve towards the role of friendly companions, in order to better relate to their users, they are increasingly anthropomorphized and humanized. In this process, the feminization of virtual assistants prevails and is often the default. This paper sought to examine the questions that arise when this phenomenon is subject to closer inspection.

In sum, we can observe a tendency to highlight the way gender (and, by extension, female stereotypes) is instrumentalized to manage interactions between digital assistants and users, as discussed by researchers and academics. In turn, common debates often advance user preference as a justification for the tendency to feminize AIs, and even popularize the belief that it's due to the field being mostly developed by men. In both contexts of discussion, the fallacy of gender neutrality among these AIs is highlighted, since anthropomorphized virtual assistants inevitably engage with common assumptions of gender.

This phenomenon also relates to the way AI is perceived in popular culture, as the portrayal of AI in science fiction often corresponds to a biased view of gender that associates femininity with submissive, caregiving roles and masculinity with aggressive or even threatening scenarios. In turn, AI developers appear to be aware of the tendency towards feminization and the biased view of gender it entails, and sometimes try to counter it. In this sense, assistants such as Siri or Google Assistant seem to be trying to become more diverse unbiased entities.

This paper sought to foster debate on how common gender assumptions influence artificial intelligence, as present in our daily lives and in our imagined realities. Ultimately, as these AIs move beyond mere assistant roles, becoming increasingly closer to us as companions, it becomes important to examine the ethical implications of this phenomenon, and tackle into the social and cultural assumptions they are reflecting back to us.

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Networked Living [1]

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As networked technologies pervade all aspects of daily life, they effectively reconfigure the ways we meet, communicate and act together. On closer inspection, these broader social and cultural shifts manifest themselves in our personal techno-mediated habits. This work uses such tech-based behavioral patterns to assemble a synoptic overview of networked sociability, its repercussions, and socio-spatial potential. The first chapter is concerned with how algorithmically-filtered online places inform the public discourse and urban space. The second chapter centers on the private sphere and the ways in which our increasingly sophisticated tools redefine the concepts of intimacy and solitude. Finally, this work assumes a critical design approach to imagine two speculative devices, Meetspace and Z-Shell – discursive objects that capitalize on our tech-fueled habit formation to suggest better practices for our media-infused future.

1 INTRODUCTION

In these times of increasing interconnectivity, our profound interdependence on techno-spatial systems dynamically restructures everyday life, together with the small rituals and habitual practices that punctuate it. This work takes a closer look into this process by tracing the influence of our habit-forming technologies on our personal relationships, sense of self, and spatial experience.

The philosophical framework of this work rests on the enduring idea that humans coevolve with their technologies. The link between embodiment and technicity can be traced back to numerous tools that have "irrevocably changed the biology, culture, and cognitions of humans" (Hayles 2010, 154). In fact, to live, think and act constitute *embodied* processes which are "essentially and originally technical" (Hansen 2006, 78). The tight coupling of the body and its tools is a core theme in the work of many phenomenologist philosophers. For instance, Heidegger reflected on the experience of using tools – which perceptually 'disappear' during action and in doing so, tend to blur the distinction between the self, the tool and the environment (Heidegger 1927). On a similar note, Merleau-Ponty offered an in-depth analysis of various prosthetic extensions and their seamless expansions of one's body schema (Merleau-Ponty 1945). While their affordances extend our agency, tools serve as mediums of thinking and action; they are a tangible means of making sense of the world. For this reason, this work adopts an understanding of cognition as *situated* or *extended,* whereby things and environments participate in the production of thought (Clark & Chalmers 1998).

In this light, the more our things become interactive and networked, the further they get involved in the ways we establish familiarity with the world through our *actions.* When these mature into habitual patterns, they are entangled with their specific devices and contexts, contributing to an ecology of *techno-mediated habits* that range from socially recognizable gestures and personal quirks to nervous tics and compulsive behaviors. Such habits are far from one-dimensional, deterministic behavioral responses to the affordances of our devices; they can be as complex as each of us and at the same time follow patterns as universal as the technologies that sustain them. Therefore, throughout this work, tech-based habits serve as a probe into the wider socio-cultural shifts that networked technologies domesticate in our life.

The following two chapters attempt to trace a suggestive map of networked sociability. Each of them is written as an episodic narrative that is more concerned with delineating the *relations* between its core elements, than analyzing their ever-changing details in depth. This approach was deemed appropriate because it accentuates the interdependency of subjects, objects, and habits, that networked living catalyzes. From a socio-political standpoint, the first chapter is concerned with the algorithmic segregation of virtual places and its consequences. It raises a series of pressing questions, such as how to establish shared experiences in a world of filtered content and tech-driven introversion; or, what kind of influence do networked social dynamics have on urban space and the public discourse. Focusing on the personal aspects of networked life, the second chapter examines how concepts of intimacy and solitude expand to accommodate our artificially intelligent companions. Also, if the latter are increasingly taking care of our homes, what are the repercussions of this on domesticity and private life? Each chapter concludes with a vignette that extrapolates the present condition to introduce a speculative device that breaks, or makes, techno-mediated habits.

2 MEET THE OTHER: VERTICAL ENCOUNTERS

In the last couple of decades, the advent of mobile computing and social networking services has changed the way we meet and socialize in urban space. Networked devices mediate our daily exchanges and activities to the extent that the line between our online and offline social life has effectively disappeared. To describe this hybridization, Turkle used the term *multi-lifing* – or, as one of her study participants dubbed his seamlessly twofold reality: *life mix* (Turkle 2011, 160). For better or for worse, the way we perceive ourselves as individuals and members of society is conditioned by the specifics of our personal life mix.

Let us take a closer look into how the virtual dimension of our life mix is conditioned. For instance, most online search engines filter their search results to accommodate our limited time and attention resources. Yet, on what criteria is information deemed relevant or redundant? It is a common misconception that information technologies are inherently neutral, rational, and just. Sophisticated digital tools are often taken 'at interface value', while their computational complexity remains hidden. In the background, algorithms make elaborate choices, such as which data to collect, how to correlate and interpret them, and what kind of actions to extrapolate. Yet, as everything manmade, algorithms are assemblages of judgments that are contingent, subjective, and potentially biased.

Similarly to search engines, most major social networks use predictive analytics to curate their content to each user's taste – extrapolated from past activity on the platform and quantified according to numerous parameters, such as the frequency, quantity, and kind of engagement with other users or entities[2]. To raise awareness about how the tech industry mines our digital footprint, *Data Selfie*[3], an open-source extension for Chrome, ran a similar but transparent simulation of predictive analytics (fig. 1, 2).

2. Stuart Dredge. "How Does Facebook Decide what to Show in my Newsfeed," The Guardian. Last modified June 30, 2014. https://www.theguardian.com/technology/2014/jun/30/facebook-news-feed-filters-emotion-study

3. Data Selfie (2016-2018) was developed by Hang Do Thi Duc in collaboration with Regina Flores Mir and Leon Eckert. It reverse-engineered Facebook's predictive algorithms by analyzing the website's rendered front-end (as it appeared in the browser window), in combination with the user's ongoing activity patterns. More details on how Data Selfie worked are available here: https://dataselfie.it/

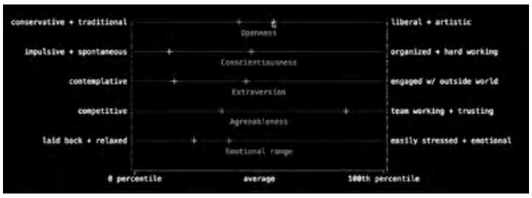

Fig. 1. and 2.
The *Data Selfie* dashboard distilled one's Facebook profile and activity into color-coded diagrams that made a variety of psycho-demographic predictions, such as (fig. 1.) the analysis of one's core personality traits and (fig. 2.) political affiliations.

Using machine learning algorithms and natural language processing, *Data Selfie* parsed Facebook activity to gauge who the person behind the account really is. Over time, it showed how something as seemingly trivial as one's social media habits gets analyzed and assembled into an uncannily accurate data portrait – in response to which the entire experience of the platform, from its newsfeed to its targeted ads, gets personalized.

With this rudimentary insight into the workings of personalization algorithms, one could attempt to circumnavigate them by deliberately diversifying their activity to expand their reach. Yet, is it possible to opt-out of the personalized web completely? For the moment, it seems unlikely. Even if we minimize our digital footprint to the best of our abilities and our tools' affordances, one thing is for certain; until we claim our 'right to be forgotten', our data portraits are here to stay.

And so are their implications. The personalization of online content through opaque algorithmic processes has social and political side-effects. Today, an increasing amount of people seem to have placed an unfounded amount of trust on their algorithmic newsfeeds, assuming that, "if news is important, news will find me"[4]. As our information diet gets automatically tailored to our taste, we find ourselves in a virtual 'echo chamber' – a familiar place that reflects our habits and reaffirms our beliefs. Adding to the growing criticism, Eli Pariser (2011) delineated the information calamity such personal 'filter bubbles' create, as well as their socio-cultural cost. He identified a couple of perceptual dangers afoot (Pariser 2011, 10-11). First, each person is alone in their bubble, which erodes a socially important common ground – that of *shared experience*. Secondly, the bubble is virtually invisible. It has neither distinct boundaries nor substantial control settings to tinker – such as those that the *Daily Me* concept newspaper imagined (Negroponte 1995, 154). Finally, no one should wish for a bubble. It might feel as convenient and comforting, but in the long run, it skews our sense of what is real, important, and possible by insulating us from different perspectives. In Pariser's words:

4. Gottfried, J. & Shearer, E. (2017, September 7). News Use Across Social Media Platforms 2017. Pew Research Center. Retrieved from: http://www.journalism.org/2017/09/07/news-use-across-social-media-platforms-2017/

> “ In the filter bubble, there's less room for the chance encounters that bring insight and learning. Creativity is often sparked by the collision of ideas from different disciplines and cultures. (...) If personalization is too acute, it could prevent us from coming into contact with the mind-blowing, preconception-shattering experiences and ideas that change how we think about the world and ourselves. (Pariser 2011, 13)

People's preference to dwell in familiar, controllable microcosms is a phenomenon as old as the social hierarchies that kept 'otherness' at bay by weaving our cities' urban fabric with segregative threads. Today, their algorithmic equivalents fragment the Internet – once envisioned as a boundless field of socio-cultural freedom – into personal 'filter bubbles' that may, in turn, affect the ways we socialize and act in public space. Taken to their extreme, the promises of certain location-based media could mean that "urbanites will never have to leave the comfort of being surrounded by like-minded people" (de Waal 2011, 193). For example, search-and-discovery apps like Foursquare might enable a gradual social homogenization of urban places by algorithmically suggesting them as destinations only to specific kinds of audiences. This is only one of the ways 'filter bubbles' might cross over to the physical realm at the expense of serendipitous encounters and social diversity.

However, different types of personal 'bubbles' already populate public space and have little to do with personalization algorithms. Instead, they are enabled by our devices as tangible objects, or rather, social signifiers. For instance, being absorbed in one's phone has become a commonplace practice of deflecting social exchanges; after all, who doesn't have more useful or interesting things to do than small-talk (fig. 3)? Also, phones communicate a much deeper preoccupation than print media. Coupled with a pair of earbuds, they establish a noise-cancelling, audiovisual cocoon that "grants the wearer a certain amount of social license, enabling one to move through the city without necessarily getting too involved and, to some extent, absolving one from responsibility to respond to what is happening around him or her" (Shepard 2011, 24). Usually, such semiprivate spheres have various degrees of permeability – as in the case of conceding to *pay partial* attention by removing only one of the earbuds (fig. 4).

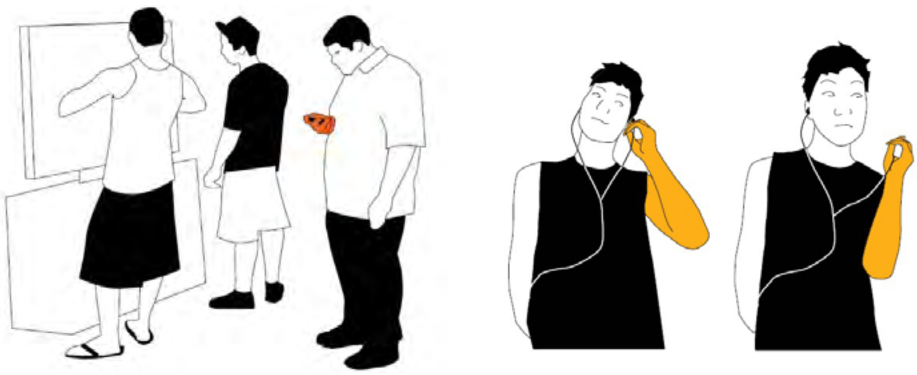

Fig. 3. and 4.
Mobile media have updated our code of conduct with new behavior patterns, such as (fig. 3) the comforting 'security blanket' that kills time, or (fig. 4) the gesture of 'halfway courtesy' that accommodates brief, casual social interactions (Nova et al. 2012).

This gesture of "halfway courtesy" (Nova et al. 2012, 95) is part of an evolving techno-social etiquette that allows for the emergence of semiprivate spheres in public space. One of the reasons behind this cultural phenomenon might be a sense of escapism from socially uneasy everyday moments. Alluding to Thoreau's self-exile, Turkle argued that these techno-mediated habits produce a "Walden 2.0" (Turkle 2011, 275), an instant emotional refuge from the real-time social expectations of our hyperconnected society. Worse, our personal 'bubbles' might engender the assumption that, it is not worth bursting them to interact with strangers in public, unless there is something foreseeably 'useful' to be gained. This couldn't be further from the truth, for as Martijn de Waal (2011, 191) explained, the very 'publicness' of space is enacted through an active symbiosis with the Other:

> “The quintessential characteristic of urban life, as urban theory since Simmel has pointed out, is that urbanites are to live together with strangers who not only will remain strangers but may also have a completely different outlook on life. Yet somehow, all citizens have to find a way to work things out.

Public space is the common ground where everyone’s differences converge, and this dynamic multitude of backgrounds, needs, and interests is precisely what produces its public function. Hannah Arendt believed that democratic societies depend on the performance of human *plurality* (Arendt 1958/1998, 7). Stressing the participatory and confrontational nature of public life, she noted that “practical politics” are *collectively* produced and negotiated, and that “they can never lie in theoretical considerations or the opinion of one person” (Arendt 1958/1998, 5). For this reason, any condition that fosters homogenization or segregation undermines the democratic momentum of the *multitude* – which is, by definition, “not a uniform entity such as a class, a nation, or a mass” (Böhlen & Frei 2010, 14).

In this light, the argument against web personalization rests on the principle that *difference is a relation*; a crucial socio-political adhesive that enables civic discussion. Yet, it only functions as such when individuals meet and negotiate. Therefore, by keeping opposed interests unrelated to each other, ‘filter bubbles’ threaten to debilitate democratic processes.

In the past decade, the rise of powerful networked movements is proof that, at least for the moment, the potency of the Internet as a political tool can hurdle the repercussions of its personalization. Online communication platforms have helped the emergence of a new kind of bottom-up socio-political action. Its first ingredient is lived experience, which is no longer confined to the private sphere. When “private matters take on public relevance” (Böhlen & Frei 2010, 17), they can evolve into a call for action, empowering underrepresented members of society and citizens of non-democratic regimes to self-organize and demand their dues. And this is where the second ingredient lies. The public sphere that online forums afford is “no longer based on bringing people with different backgrounds and opinions spatially together (as in coffeehouses or town squares), but on the organization of publics around particular issues of concern” (de Waal 2011, 190). These purpose-driven social bodies, despite being assembled digitally, tend to mobilize ad-hoc interventions in physical space. As a result, networked publics could be a lever of social change towards more participatory forms of governance.

However, this expanded public sphere doesn’t come without challenges. Internet-fueled movements may spread like wildfire, but their momentum is much tougher to sustain. According to some scholars, their weakness is that, absorbed as they are in the pursuit of the common goal, harnessing the power of their social diversity comes second. For this reason, the function of public space as a field where people’s differences converge remains key to networked publics. Another problem is that networked protests are vulnerable to disruptive interferences, from Internet shutdowns to misinformation. What happens when the same algorithms that personalize our web experience are also filtering our access to significant information?

Also, as we become increasingly conditioned by our virtual comfort zone, how do we engage with social diversity and political action in public space?

Networked publics, as ad-hoc, cause-driven and hyperlocal social bodies, produce an expanded public sphere that is quite different from Arendt's enduring, confrontational and situated one. Yet, the two are not necessarily mutually exclusive. The following vignette imagines a post-smartphone device which reappropriates the tools of the former to reactivate the latter as a hybrid social space.

2.1 Meetspace

As personalization algorithms cater our web experience to our habits, it becomes increasingly unlikely to encounter people online that could challenge or diversify our belief system. Worse, we are rather unaware of the complexity filtered out of our virtual microcosm. Besides compromising people's access to a shared pool of information, personalization algorithms are also influencing the ways in which we encounter others in virtual space; think of how users with whom we don't generally interact, disappear from our social media newsfeeds, or how effortlessly normal it is to block users we disagree with.

Thankfully, this is not possible in meatspace, and for a few good reasons. As individuals, we are shaped by our exposure to difference. An absence of the Other compromises the relational dimensions of our identity, impoverishing not only our self-awareness but also our ability to empathize and act together. If our online activity gets compiled into data portraits, how could we reappropriate them to burst the 'filter bubble' they condition and engage with the Other in person? **Meetspace** is a device that offers a body-based mismatch-making service.

Sensing

Each **Meetspace** glove features an embedded RFID tag[5], linked to the wearer's online data portrait. When worn in public, it scans one's immediate proximity for people who are significantly different from oneself. When two gloves detect each other's presence, they automatically initiate an external, online process of comparison between the linked data portraits.

5. It needs to be clarified that the passive RFID tag used in this prototype is a placeholder. It was chosen for its small size and flexibility, but it has its limitations. Technically, it cannot perform as envisioned here, surely not without additional hardware support. In the future though, it is safe to assume that more powerful and independent RFID tags, able to switch between active/passive states and trigger more complicated actions, will be commonplace.

Actuating

If the detected data portraits are far different from each other, **Meetspace** acts as a sort of 'diversity sensor' and informs each wearer of the Other's presence through a tangible notification. The glove's inner side inflates (fig. 5), alluding to the sensation of another hand during a handshake – the shared, courteous gesture that symbolizes the beginning of a personal relationship.

Fig. 5. and 6.
(left) **Meetspace** in an inflated state. (right) Before the handshake, the wearables deflate each other to make room for the stranger's hand.

Meetspace intends to act as an ice-breaker for spontaneous, one-on-one social encounters which are often intimidating to initiate with complete strangers. In this light, **Meetspace** aims to become a conversation starter, updating our code of conduct accordingly. However, whether a conversation will eventually happen or not is entirely up to the people involved. Will they grab the opportunity to meet someone with a radically different background and outlook on life – to whom they would probably never have been exposed within their 'filter bubble'? Is the prospect of an unpredictable, open-ended conversation intriguing enough to make people leave their comfort zone in public space?

If both strangers extend their hands, the gloves detect each other and deflate, allowing for a firm handshake to take place (fig. 6). Yet, some people might choose to ignore the opportunity to socialize and walk away – but they will do so, being aware of the social diversity of the context they find themselves embedded in.

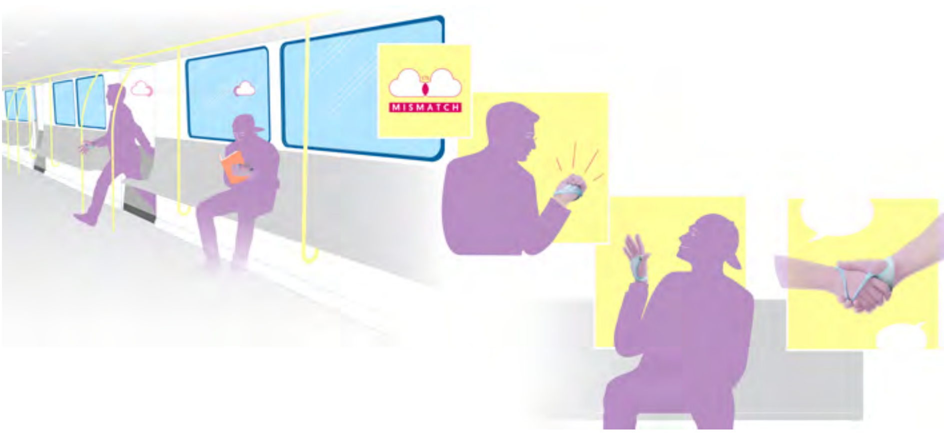

Fig. 7.
Storyboard for **Meetspace.**

3 NETWORKED INTIMACIES

> Technology proposes itself as the architect of our intimacies.
> (Turkle 2011, 1)

New media and communication technologies expand the ways in which we shape our identity, redefining our experience and understanding of intimacy and solitude. During this process, our devices become increasingly near and dear to us, entangled in the personal bonds they sustain as both means and *objects* of affect. Philip K. Dick did not wonder whether *humans* dream of electric sheep; he already knew the answer.

In fact, there are two kinds of dreams that govern our relationship with technology, as expressed through robots (Turkle 2011, 342). In the first one, we hybridize with them by gradually assimilating bodily and cognitive extensions. In the second one, they stand by our side, better companions than any human could ever be. As products of distinct philosophical frameworks, these dreams understand the relationship between human nature and technology quite differently. In both of them though, the robot is far from a mere tool. Instead, it becomes an embodied system with the ability to *feel*.

In our electric dreams, as much as in our everyday life, we develop a reciprocal coupling of sense and affect with our technologies. It soon becomes clear that the aforementioned ‘cyborg’ and ‘companion’ scenarios are unfolding at the same time, informing our social sensibilities. One of the most powerful examples of the latter is that of ELIZA (1966), an early conversational program designed by Joseph Weizenbaum at the MIT Artificial Intelligence Laboratory. Impersonating a psychotherapist, ELIZA would ask brief questions or make emphatic statements by rephrasing the user’s input. For instance, if someone referred to a dream they had, the program would respond with a question along the lines of:

> “What does that dream suggest to you?
> What persons appear in your dreams?
> Do you believe that dreams have something to do with your problem?
> [Excerpt from ELIZA’s script (Weizenbaum 1966, 44)]

But there was something uncanny in the way Weizenbaum’s students conversed with the program. Turkle, who was one of them, recalls that as time passed by, the dialogue would get more and more intimate (Turkle 2011, 23). Many people confided in ELIZA personal experiences, concerns, anxieties and hopes – some even asked to be left alone with it. Weizenbaum was taken aback by how his students willfully projected credibility and compassion on such a rudimentary program, despite knowing beforehand that it was not intelligent. In addition to that, he initially expected that as soon as the code’s limitations were exposed mid-conversation, ELIZA’s “aura of magic” would instantly collapse (Weizenbaum 1966, 36). Instead, the students remained intrigued. Wary of his creation’s potential for deception, he concluded that it “shows, if nothing else, how easy it is to create and maintain the illusion of understanding” (Weizenbaum 1966, 43).

However, Turkle had a different take on the matter. She argued that the students were deliberately using ELIZA as a platform of expression and introspection. Some even adapted their responses to its limitations in order to extract more lifelike answers. To them, the program’s demystification did not expose a conversational dead-end, but rather a framework they could work with. This “ELIZA effect”, as Turkle (2011, 24) termed it, described people’s eagerness to meet their non-human companion halfway, fascinated by its imperfect *performance* of intimacy and understanding.

ELIZA was limited as an experiment exactly because it had no understanding of the meaning of the words it processed, nor did it store any of them for future reference; yet, a truly conversational program needed the ability to learn. The future ELIZA, Weizenbaum (1966, 43) argued, should be able to refer to an external pool of information and learn from it. Secondly, it should be able to *learn* from the process of conversation itself. This way, the program could develop its own skills further, but also form a knowledge of who its conversational partner is and *personalize* its responses.

Today, we are still enchanted by the idea of technologies with simulated social skills. ELIZA's highly sophisticated successors have entered our homes and we cannot resist chit-chatting with them. Virtual assistants such as *Google Home* or Amazon's *Alexa* 'know' what they are talking about, using machine learning algorithms and the Internet as a reference. In addition, they analyze and learn from people's use over time, checking all of Weizenbaum's boxes.

Taking it one step further, voice-based Artificial Intelligence applications are purposefully designed for more intuitive and personalized interactions. Their advanced speech technology pushes keyboards and screens aside, enabling a more frictionless and embodied relationship to technology – one that is also thoroughly customizable. For instance, Alexa can be programmed to tell inside-jokes and pay personal compliments. For reasons of inclusivity, it is also fluent in a few languages and their dialects, but also *accents*. Imagine a warm voice that speaks English with an Indian accent[6], filling your home and jokingly guiding you through a recipe – is this your friend, or an overly humanized operating system? Our voice assistants sound cocky and casual, but also speak *as if* they have a cultural heritage or a background of immigration and adaptation. It is no longer enough for them to perform understanding and empathy – we would like them to have a personality, an *identity* of their own.

The influence of voice assistants on the performance of our daily routines is evident in what people ask them for. According to Amazon's 2017 usage statistics, some of the most prevalent requests are along the lines of "Alexa, help me relax"[7] . If tens of millions of Alexas operated in the world by that time, then the vast majority of their humans were asking for advice on how to sleep better or meditate. Thus, it was only a matter of time until such a funny, relatable and caring voice assistant received marriage proposals[8]. Of course, people confessing their feelings to Alexa might as well be kidding, but they engage in a now *mutual* performance of pseudo-intimacy.

6. James Stables. "This is what all of Alexa's accents sound like," The Ambient. Last modified August 8, 2018. https://www.the-ambient.com/features/alexas-accents-listen-325

7. George Anders. "Alexa, Understand Me," MIT Technology Review. Last modified August 9, 2017. https://www.technologyreview.com/s/608571/alexa-understand-me/

8. Blake Montgomery. "A Quarter of a Million People Have Proposed to Amazon's Virtual Assistant Alexa," Buzzfeed News. Last modified October 27, 2016. https://www.buzzfeednews.com/article/blakemontgomery/lots-of-people-have-proposed-to-amazon-alexa#.eblPl6lanX

Fig. 8. and 9.
Stills from Her (2014), directed by Spike Jonze. In this scene, the protagonist is woken up by Samantha. She is an advanced operating system.

A year before Amazon's product was launched, Spike Jonze's film *Her* (2014) illustrated our electric dream of companionship quite gingerly (fig. 8, 9). It traced the emergence of an intimate relationship between a lonesome man and Samantha, his highly intelligent and affectionate operating system. Jonze's extrapolation of human relationships into the not-so-distant future presents us with an emotional antihero – an author who writes heartfelt personal notes to strangers for a living, but is unable to communicate meaningfully with his own partner. As Samantha untangles his inner knots through conversation, we might witness what made Turkle uneasy to identify as the "*deeper* ELIZA effect" – it is less about an eagerness to talk to computers, and more about a reluctance to talk to people (Turkle 2011, 282). Thus, our collective dream of artificial companionship may root back to a discomfort with the complexity of human relationships.

One of technology's most enduring promises is that of *control*, and we might be misusing it to attenuate the messiness of being with humans. Indeed, as mentioned in the previous chapter, personalization algorithms keep virtual places conveniently free from real-life confrontations and negotiations. In this absence of social friction thrives a new kind of techno-mediated togetherness – gratifying, on demand, but not too committing. As a result, one of Turkle's major points of criticism on social networks is that this *controlled intimacy* can only produce weak social ties (Turkle 2011, 280) that may expand the periphery of our social circle, but rarely its center. Online, we are in each other's continuous partial company, and this might be all that our social networking platforms allow for in their current form.

It is widely considered that the ways we communicate are conditioned by the affordances of our media. For example, our prevalent texting and email culture tends to undermine nuanced meaning because it is geared towards rapid, light-weight and efficient exchanges. Yet, texting and emailing remain our preferred means of communication for two reasons. First, they are easier on our overburdened attention span because we can attend to them quickly and whenever we choose. Secondly, they give us a sense of being more in *control* in terms of content, but also social exposure. Phone calls, for instance, are lately considered intrusive because they demand that both partners are engaged in the conversation simultaneously. One thing is for certain: our communications are poorer without hesitant pauses, animated intonation and personal mannerisms. Although we grapple with training our voice-based AIs to pick up on such nuanced vocal cues[9], we seem to underestimate their role in building more meaningful and intimate bonds.

9. Will Knight. "AI's language problem," MIT Technology Review. Last modified August 9, 2016. https://www.technologyreview.com/s/602094/ais-language-problem/

Voice assistants are part of the so-called 'smart home' vision which capitalizes on another one of technology's promises – that of *leisure*. At the end of the day, this electric dream usually concludes in a comfy bedroom, fully-automated by subservient ambient technologies, where we can unwind and casually indulge in our bedtime media routine. We might shoot some emails, answer a text or two and then follow a jumpy path of online activities, only to find ourselves *busy*, in bed.

Networked technologies convert the bed, the center of private life, into a horizontal workspace. Notably, a 2012 market research found that as many as 80% of young professionals in New York City were working from home in *their beds*[10]. Framed by all sorts of networked and smart technologies, the bed becomes the ultimate prosthetic in the pursuit of ceaseless productivity. In a recent essay, Beatriz Colomina argued that:

> The bed itself—with its ever more sophisticated mattress, linings, and technical attachments—is the basis of an intra-uterine environment that combines the sense of deep interiority with the sense of hyper-connectivity to the outside.[11]

Our techno-mediated bedtime habits go beyond just work. Other activities include, according to Colomina, those of socializing, reading the news, or checking one's match-making apps. The bed becomes a gratifying zone of information and entertainment, fueled by our inner 'fear of missing out' and a profound discomfort with being alone, unplugged, and inactive. Our devices fill these gaps mostly as information channels, but also as transitional objects; sometimes, we find more comfort in the process of looking for content than the content itself. Thus, our phones are often subjects of compulsive habits, whereby just having them in hand, touching them, or opening apps without a particular purpose in mind becomes subconsciously reassuring for us. And all these habitual behaviors might be bound to concretize others in the long run. As Nicholas Carr (2010) noted, it is possible that they could be rewiring the brain to accommodate the demands of our unruly networked lifestyle. As a result, we might find it increasingly difficult to unplug and be mindfully 'here, now' because the circuitry of our mind has changed.

Traditionally, intimacy thrived in privacy, but in a hyperconnected world of people and things the personal sphere becomes a shared enterprise. If the bed is a workspace, then sleep is just another means of production to be analyzed and optimized. Indeed, at bedtime the voice assistant could fill the bedroom with soothing ambient sounds while the thermostat maintains an optimal sleep temperature, the fitness tracker could monitor sleep quality and set the smart bed to support the body accordingly, and so on – yet, how did we come to think that the cause of our sleeplessness was a *lack* of such automated comforts? Amidst a plethora of technological solutions looking for personal problems, it is tougher to discern the latter's social underpinnings. Only if we ask better questions about our personal and social practices, will our technologies become part of the answers.

The final vignette considers the potency of bedtime rituals as acts of self-care, but also as interpersonal generators of tacit intimacy. The shared practice that the following speculative device affords, reclaims the bed as a place of stillness, self-reflection and reverie.

3.1 Z-Shell

In recent years, a growing body of research has outlined the pitfalls of sleeping with our devices. For example, their bedtime use disassociates sleep from the bed on a subconscious level and tends to overstimulate the mind,

10. Sue Shellenbarger. "More Work Goes 'Undercover'," The Wall Street Journal. Last modified November 14, 2012. https://www.wsj.com/articles/SB10001424127887323551004578116922977737046

11. "Relaxation techniques: Breath control helps quell errant stress response," Harvard Health Publishing, Harvard Medical School. Last modified April 13, 2018. https://www.health.harvard.edu/mind-and-mood/relaxation-techniques-breath-control-helps-quell-errant-stress-response inviting intrusive thoughts in our time of repose. Even the blue light that screens emit is known for disrupting our circadian rhythm, resulting in a domino effect of health problems.

Although going to bed without gadgets does not seem like an option to many of us, when we funnel all of our attention and personal time elsewhere, we devalue the direct, unmediated experience of the place we find ourselves in. If our collective desires are these of intimacy and connection, we may come to realize that being at peace with one's unplugged self is key for more fulfilling personal relationships with our loved ones and our community. In addition, personal relationships with close friends, partners, and family members are sustained by meanings that cannot, or do not have to, be always explicitly expressed; it is a common ground that does not have to be put into words to exist. This kind of meaning, the one that already dwells within people, is implicitly conveyed in their mindful presence – even when performed asynchronously and from a distance. **Z-shell** introduces a practice of introspection for revisiting and cultivating shared meaning.

Fig. 10. and 11. The device in a deflated state.

One of the best ways to practice mindful presence is through breathing exercises. Most of them originate in eastern cultures and have been scientifically confirmed as beneficial for one's mental and physical health. To increase one's concentration, various *slow breathing* exercises combine deep inhalation with elongated exhalation. There is also a wide range of asymmetric *breathing regulation* techniques [12][13], which help achieve deep relaxation and sleep.

Such breathing exercises are not as easy to perform without an instructor or outside a prescribed routine. The asymmetric ones can be especially challenging for beginners, who often experience the process of counting seconds to control their breathing rhythm as a counterproductive cognitive load. In general, breathing exercises require some practice, but the more reflexive they become, the more profoundly effective they will be.

12. Sarah Novotny and Len Kravitz. "The Science of Breathing," IDEA Fitness Journal, 4:2 (2007), 36-43. http://www.unm.edu/~lkravitz/Article%20folder/Breathing.html

13. Dr. Andrew Weil is the Director of the Arizona Center for Integrative Medicine at the University of Arizona. He has been reappropriating yogic breathing techniques to develop breathing patterns that promote relaxation and sleep. The most successful one seems to be the 4-7-8 exercise. To perform it, one inhales slowly for a mental count of four seconds, holds one's breath for seven, and exhales for eight. More on Dr. Weil's breathing exercises can be found on his website: https://www.drweil.com/health-wellness/body-mind-spirit/stress-anxiety/breathing-three-exercises/2/

Sensing

When not in use, **Z-shell** usually rests deflated on the bedside table (fig. 10, 11). To begin the bedtime ritual, one may simply breathe into its con-cave part. There, an embedded sensor picks up the temperature fluctuation caused by inhalation and exhalation, allowing **Z-shell** to identify one's respiratory rate.

Fig. 12. and 13.
(left) Measurement of the current breathing rate, (right) Demonstration of a breathing exercise.

Actuating

At first, **Z-shell** begins pulsating its inflation chamber in sync with the user's breath and then gradually transitions towards the exercise pattern. In principle, the device performs the breathing exercise in the users' hands (fig. 13). By converting an otherwise tricky mental task into a reflex response, **Z-shell** helps oneself focus on what matters – the pacifying sensation at hand, one's breathing rhythm and ultimately, simply being present in the moment. The exercise session may continue for as long as needed.

When **Z-shell** is paired with anwother device, its role does not stop there. Once the exercise session is over, one's own device resets back to a deflated state, but another device somewhere else inflates in response, awaiting its owner to engage in his or her own time. In this light, **Z-shell** mediates an asynchronous, but shared experience of an intimate everyday ritual between people, allowing them to communicate in a more reciprocal, embodied and affectionate way.

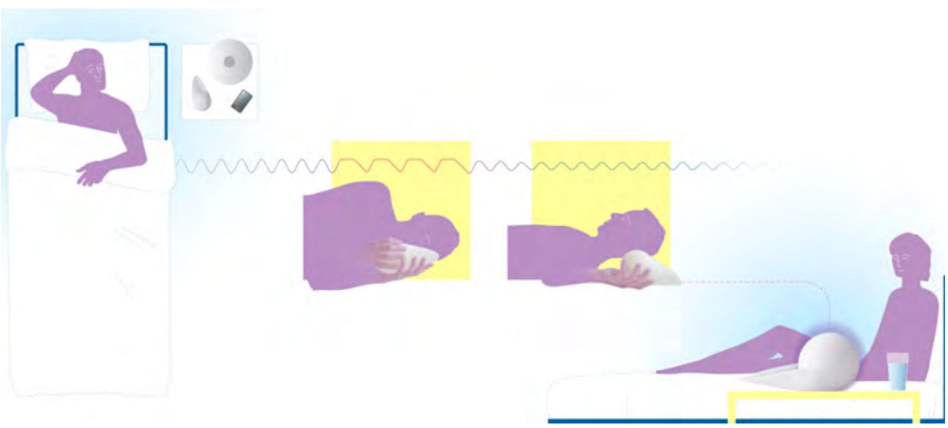

Fig. 14.
Storyboard for **Z-Shell**.

4 CONCLUSION

This work explored the multifaceted nature of networked sociability through the lens of our techno-mediated habits. Its theoretical framework touched on notions of embodiment and extended cognition to argue that tools shape not only our actions but also how we perceive ourselves and our environment.

The first chapter considered various forms of networked sociability and their manifestation in physical space. For instance, online content personalization may seem convenient and benign, but it might also devolve into an ideological echo chamber. For this reason, public space – an enduring field of confrontation and negotiation that is built on shared experience – offers a fertile ground for the emergence of networked publics under a common cause. The first vignette described **Meetspace**, a device that exploits the wearer's 'filter bubble' to initiate encounters that celebrate socio-political diversity in urban space.

The second chapter explored the duality of networked intimacy – mediated towards others, but also our increasingly intelligent technologies. Examples of the latter can be found in how early conversational programs, and their contemporary AI successors, appeal to our electric dreams of companionship. However, our attraction to simulated intimacy might also be suggestive of a subconscious desire to temper the complexity of human relationships. In the meantime, network dynamics have infiltrated the bedroom, the home's most private core, converting it into a hyperactive field for work and leisure. The last vignette presented **Z-shell**, a device that restores the bed as a tranquil retreat through a shared bedtime ritual.

This work used speculative design practices to suggest that different relationships to our networked technologies are possible. The produced prototypes do not present themselves as answers, but rather as contributions to the debate that might shape them. In fact, most of the pressing issues that this work is concerned with could only ever be resolved on a socio-political level – but the seeds of collective arguments are sown by engaged individuals. To claim a common future of constructive media and spatial practices, it is crucial to be self-critical of our techno-mediated habits, to challenge the designated use of our tools, and to attend better to our context, but also ourselves.

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DEEP SOLUTIONS: Artistic interventions in platform capitalism

Keywords
social media
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interactive art

The business model held by platforms like Facebook and Google is dependent on practices of user tracking and data collection. These practices place their users in a highly asymmetrical position in which platforms know significantly more about their users than users are able to know about the tracking strategies of platforms. This paper argues that media artworks are uniquely equipped to level these asymmetries by creating sites that reveal the inner workings of these processes. We present a virtual reality installation called DEEP SOLUTIONS that aims to interpret the data that is collected by Facebook, creating an environment wherein issues of platform surveillance are contended with and experimental alternatives are proposed.

1 INTRODUCTION

The project we are presenting is centred on themes of surveillance and commodification within the everyday spaces of the internet. Platforms like Google and Facebook have become primary access points to the internet, thriving on an economic model that has recently been referred to as surveillance capitalism (Zuboff 2018). These platforms rely on the collection of user data, rendering user activity as a commodity that is exchanged with marketers, advertisers, political campaigns and other actors.

Due to legislative pressure, Google and Facebook now provide limited means to view the data that is stored on their users (Böhmecke-Schwafert, Niebel, and Berlin 2018, 4). This information, however, tends to be sequestered deep in application settings, far from the viewing, "liking" and sharing behaviours these platforms primarily afford. Furthermore, this information tends to be of such a significant quantity and variety that any effort to access and comprehend it requires some extraneous means of contending with its sheer magnitude and complexity.

This fundamental asymmetry between the data stored through tracking systems and its limited accessibility to users presents a significant opportunity for artistic intervention, in which strategies of narrativization, data visualization and virtual worldbuilding might work towards elucidating these murky but ubiquitous systems. The artwork we are presenting in this paper, entitled DEEP SOLUTIONS, attempts to seize upon this opportunity through the creation of a personalized VR experience based on the data collected by Facebook's algorithms. This paper will outline the research, artistic process and audience interactions that resulted from the creation and exhibition of this work. Drawing from our experiences creating this work, we also present questions that consider the possibilities, challenges and contradictions that emerge through the process of visualizing the surveillance systems that are deliberately kept hidden by monopolistic media platforms.

2 CONTEXT

In the past decade, ubiquitous computing has become woven into the fabric of everyday life. Innovations in high-speed networking, high-resolution sensors, predictive algorithms, microelectronics and data collection, while creating myriad opportunities for the mediation of nearly all realms of social life, have also afforded a magnitude of new sites of increasingly pervasive forms of surveillance. As the networked technologies that characterize the "internet of things" expand into new spatial configurations, the scope of monitoring processes, too, creeps further into the physical spaces where encounters with interactive systems occur. Mark Andrejevic has used the term ubiquitous surveillance to describe a world in which "it becomes increasingly difficult to escape the proliferating technologies for data collection, storage and sorting" (2012, 92).

Ubiquitous surveillance is derived from a related term, ubiquitous computing, which has come to characterize the assemblage of embedded networked technologies that has proliferated into public space and into the home. While buzzwords such as "smart technology" and "cloud computing" have been used in the marketing of GPS-enabled mobile devices, home automation tools, transit systems and payment devices, these terms do little to elucidate the processes of data collection and commodification that passively occur through everyday interactions. "If the goal of ubiquitous computing," writes Andrejevic, quoting from MIT's Project Oxygen initiative, "is to 'bring abundant computation and communication, as pervasive and free as air, naturally into people's lives,' it does the same thing for surveillance" (2012, 92). With each innocuous, technologically-mediated gesture – tapping an RFID-embedded transit card at a turnstile, for instance – results the expansion of the data-fied ghosts that follow our movements through public spaces.

Inasmuch as online environments and social media platforms extend and mediate public space, we can also examine the data collection strategies of internet monopolies as components of a larger, ubiquitous surveillant assemblage. Data collection is built into the economic model of free online services like Facebook, whose profitability depends upon the unfettered collection of user data which is transformed into a saleable commodity. Coupled with the affordances of digital platforms, which actively encourage the sharing of personal information, the capacity of social platforms to collect and retain highly personalized information about their users is unparalleled. This informational body that reflects the material self has been referred to as the "data double": a mirrored, quantified version of the self whose engagement with interactive technology draws from – and, in many ways, determines – the behaviours and experiences of its human equivalent (Haggerty and Ericson 2000, 606).

Andrejevic indicates that the data collection practices of online platforms work to enact a digital enclosure: a space delineated by the range of sensors, data collection systems and storage technologies. Evoking the notion of enclosure, which conceives of prisons, hospitals, factories and families as institutions that impose control on subjects through the logic of interiority, (Deleuze 1992, 4) Andrejevic argues that digital enclosures separate "users from the product of their activity enabled by the capture of control over the productive resources they use" (2012, 93). The spatial connotation of the term "enclosure" is useful, as it provides a dynamic paradigm to describe the manner by which users pass through a variety of different spheres of electronic mediation, which are all characterized by an interoperability of protocols and services. Each moment that a user interacts with a digital enclosure is a moment in which metadata can be extracted and stored. While these processes of capture, storage and analysis are fundamental to the promise of convenience upon which digital enclosures are predicated, they also manifest an alienating imbalance of power towards their subjects. A striking asymmetry has emerged, in which interactive systems have access to a significant amount of information about their users, while their users have very little means to scrutinize the surveillance practices embedded within those very systems.

Trends in HCI design have recently turned towards the creation of transparent systems that, rather than presenting materially obtrusive interfaces, blend into the background, seamlessly integrating themselves into environments (Gates 2011, 184). This turn towards immateriality and inscrutability poses significant challenges in critically engaging with the dataveillance that is conducted by interactive systems. The logic of "black-boxing" – a term introduced by Bruno Latour to describe the tendency of the inner workings of complex technologies to become increasingly concealed to their users as technologies become increasingly complex (1999, 70) – is amplified through the development of increasingly seamless and immaterial interfaces with embedded systems, broadening the critical blind spot that prevents users from understanding the extent of data collection practices. The seductive affordances of platforms like Facebook, in addition to their seamless interfaces and underlying algorithmic complexity, serve as barriers that prevent users from truly contending with the ramifications of dataveillance practices.

As technological interfaces continue to embed themselves within social life with less and less visibility, it is of increasing importance to create sites that reveal the inner workings of these processes. This paper argues that media artworks are uniquely equipped to generate sites of critical surveillance awareness. This paper will examine two methods by which interactive artworks reveal and contest surveillance systems: they can remediate surveillance technologies, making visible the often-concealed processes of such technologies; and they can provide tactics of counter-surveillance for audiences towards imagining radical alternatives to monopolistic and surveillant platforms. We present our 2018 virtual reality installation DEEP SOLUTIONS as an intervention within the digital enclosure that makes use of these methods towards a personalized participatory artwork.

3 DEEP SOLUTIONS

In the summer of 2018, we were given an opportunity to create a hybrid performance and installation work for the WRECK CITY residency, which paired artists with various buildings in Calgary, Alberta slated for eventual demolition in which to develop work for a temporary, hands-on exhibition. Considering the unique circumstances of this project, we decided to take on issues of dataveillance and privacy through a three-part installation: one part performance, one part immersive VR installation, and one part crypto-internet café.

Our work began with an examination of the data Facebook provides through its "Download Your Information" tool. Introduced in advance of Europe's GDPR data rights legislation, this tool provides users with the ability to download the entirety of their publicly shared content (posts, likes, photos), as well as much of the information that has been derived from tracking systems that monitor user behaviour (ad profiles, location data). Users are given the option to download this information in machine-readable JSON, CSV or XML formats (Böhmecke-Schwafert, Niebel, and Berlin 2018, 4). While these formats are intended to maximize interoperability with other software systems and social platforms, they do little to make readable the glut of archival material for everyday users interested in understanding how their information has been collected. The sheer magnitude and codified complexity of this information, in its "raw" form, poses a significant barrier in providing any meaningful knowledge for users. "Database-generated forms of 'knowledge'", write Andrejevic and Burdon, "are not accessible in the way that other forms of knowledge are" (2015, 21). They continue: "Data mining privileges those with access to the data and the technology when it comes to generating actionable information that may neither be fully explicable … nor reverse-engineerable." Despite the Sisyphean premise of reverse-engineering big data epistemologies, we opted to create a tool for translating these massive, machine-readable archives into information that could be directly encountered.

With DEEP SOLUTIONS, we wrote custom software that extracts visual material and text from Facebook user data, which is then implemented in a customized, immersive virtual reality experience where users can directly encounter the uncanny similarities and dissimilarities between themselves and their data doubles. One component of this software analyzes the location history database that is included with Facebook's user data archive. Ordinarily, this information appears as a list of WGS84-formatted geographical coordinates, which, in their raw form, are an abstraction that conceals the social relevance of the locations contained within. The software we developed extracts panoramic Google Street View images from locations found in downloaded user data, allowing the viewer to physically explore the timeline of locations within a navigable VR environment.

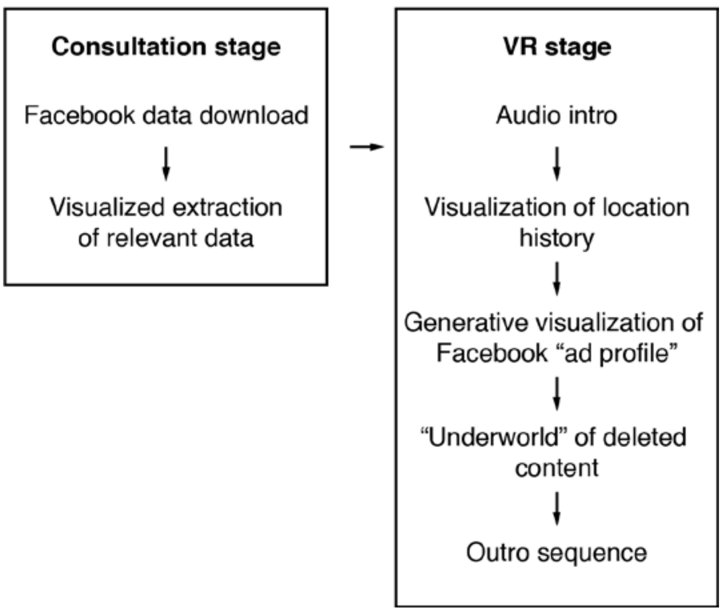

Fig. 1.
Flowchart outlining stages of interactive system

The interpretation and visualization of users' Facebook data is separated into several stages, including a hands-on consultation phase and a sequence of customized VR scenes (Figure 1). In order to accommodate the lengthy, involved process of downloading individuals' user data, *DEEP SOLUTIONS* is first presented to the audience as a consultation kiosk, in which users are invited to troubleshoot the existential quandaries of their online selves with a tech support specialist (Figure 2). In this role, we lead audience members through the process of downloading their user data. This process, which can take upwards of 20 minutes, provides a context to have discussions with visitors on issues of privacy and surveillance. Many visitors, for instance, indicated that they had no idea they had consented to giving Facebook access to location services on their phones, which was brought to light through the presentation of a stream of logged GPS coordinates on a screen in our consultation area.

Fig. 2.
DEEP SOLUTIONS consultation area

With the completion of this extraction process, the viewer is led into a VR installation, where they are invited to confront the ghosts of their data, as visualized through generative landscapes and personified through animated characters. (Figure 3) After being led through a panoramic reconstruction of their location history, the viewer descends into a series of showrooms that present imagery derived from their advertising profile, highlighting the algorithmic misinterpretations of the interests and desires of the user. These showrooms are littered with objects textured with advertising images, and their walls are plastered with interactable ads. If an ad is looked at directly, a gaze tracker triggers a scene change, leading the user to subsequent spaces that are increasingly saturated with ad imagery.

As the experience goes on, these virtual spaces become populated with ghoulish, personified manifestations of the information that users wanted to forget, uttering the text from deleted posts and tagged with the names of "unfriended" friends. These data ghosts wander aimlessly in the virtual data-realm as a reminder that data collection systems insist on remembering even what we intend to forget. Starting with the familiar backdrop of recent activity, posts, locations and "likes," this 10-minute VR experience gradually leads the viewer into a dark, uncanny underworld populated by deleted content, targeted advertisements and excommunicated acquaintances.

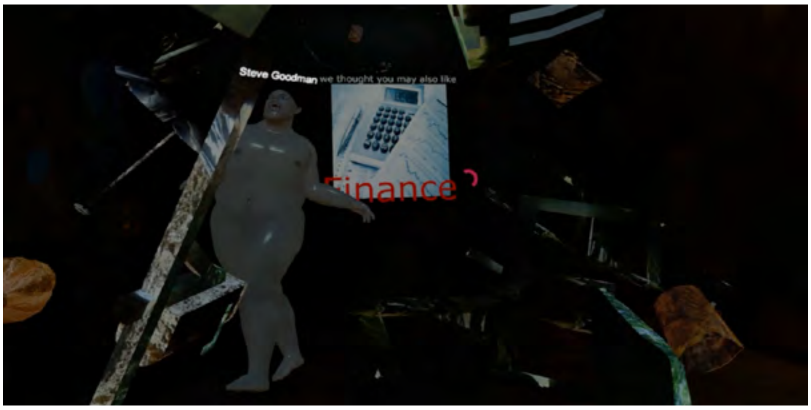

Fig. 3.
DEEP SOLUTIONS virtual reality environment

While this experience is intentionally narrativized into a sort of satirical, cinematic experience, it is followed up with a third, more pedagogical component: a crypto-internet café, in which users are presented with counter-surveillance tools that provide alternatives to the ubiquitous surveillance of popular social media (Figure 4). This "café" is situated in a room entirely clad in aluminum sheeting, functioning as a Faraday cage that prevents electromagnetic signals from entering or exiting the space and rendering devices like cellular phones mostly unusable. The only access point to the internet within the space is a computer outfitted with the Tails operating system, a Linux-based OS provisioned with built-in tools for anonymity and data security (Dawson and Cárdenas-Haro 2017, 49). The Tails OS, unlike most operating systems, deletes all files each time the computer is started up, preventing the retention of personally-identifying information. Internet traffic in Tails is routed through the TOR network, an encrypted protocol that conceals a user's location by redirecting it to a series of randomly selected, geographically dispersed "relays." As Dawson and Cárdenas-Haro describe, "The TOR is a dynamic network that is constantly evolving ... the path that our packets take changes all the time making things harder and harder for the observer" (2017, 48). The TOR network also enables the creation of hidden services, an anonymized and encrypted interpretation of the domain names and websites available on the open web.

Fig. 4.
Faraday Cage internet cafe

Viewers who access the computer in DEEP SOLUTIONS' faraday cage are presented with a variety of hidden services, which range from encrypted and anonymized social networks, to privacy advocacy groups, to technical instructions for installing the TOR network and the Tails OS on one's home computer. Eric Volmers, in his Calgary Herald profile of the exhibition, wrote: "it fittingly feels like being locked inside a giant, tinfoil hat" (Volmers 2018). While the paranoia and seediness commonly associated with dark web spelunking is certainly still present within this project, its intention is ultimately to reveal that, beyond these stereotypes, encryption technologies present real alternatives to mainstream internet platforms that are increasingly within reach of everyday users. "Dark web" social networks circumvent the ubiquitous surveillance strategies woven into the functionality of major platforms, providing tactics of anonymity for users concerned with privacy – in particular, the marginalized and activist communities who are disproportionately affected by surveillance (Gehl 2016, 1232).

The combined aim of the three installation approaches of DEEP SOLUTIONS was to engage with the public directly around issues of surveillance and privacy on the internet. The hands-on, face to face nature of the exhibition provided several unique opportunities for audience engagement: to facilitate highly customized visualizations of each participant's personal "data double"; to generate conversations with the public about the role of surveillance practices in everyday technological mediations; and to allow the audience to explore counter-practices that contend with ubiquitous surveillance on the web. The face to face interactive pedagogy facilitated by this exhibition allowed for a careful, personal negotiation of the trust involved in the vulnerable exchange of highly personal data. This project sought to draw audiences into a playful space of interactivity towards the facilitation of a transformative, heuristic space in which surveillance, datafication and power could be embodied, understood and critiqued.

4 CONCLUSION

Interactive digital artworks and participatory media platforms have much in common. They both present audiences with interfaces that solicit interactions, and they both make use of algorithms that process interactions and determine content. In this sense, artists that work with code have a unique perspective towards media systems: their own creative process is itself a process of working with the algorithmic underbelly of technology that is ordinarily left hidden behind interfaces. This algorithmic perspective comes with it unique opportunities for re-purposing and re-representing dataveillance systems towards more transparent configurations. Conversely, artists repurposing algorithmic tools to critique surveillance capitalism must be cautious not to replicate the quantifying subjectification of dataveillance by merely aestheticizing it.

Critics of surveillance art have cautioned against this sort of aestheticization of surveillance and counter-surveillance. Torin Monahan, for instance, has criticized the manner in which artworks "frame problems with surveillance as universally experienced or as needing individualized and product-based solutions to manage – rather than correct – systemic social problems" (2015, 173). How can artists expand on narrow framings of surveillance towards forms of resistance that more significantly impact the marginalized populations that are most significantly affected by surveillance? And, is the art gallery really an effective space to stage this sort of resistance? Artists working towards critical reconfigurations of surveillance technology must consider the trappings of aesthetic simplifications and expand their research into broader disseminations: beyond the limited aesthetic scope of mere playful interactivity and beyond the limited audiences of the art world and the academy, whose enclosures might further exclude communities most acutely impacted by surveillance.

Along similar lines, critics of the cryptographic solutions we have discussed have questioned the efficacy of such counter-surveillance technologies. Gurses et al. claim that the prioritization of encryption tools as fixes for the problems posed by surveillance implies that these problems can be managed with band-aid solutions, sidestepping the real critique necessary to effect actual change. "How the problem is defined already involves assumptions about whose experiences of surveillance are to be addressed," write Gurses et al, "and whether it seems possible to 'design away' the problem or whether a broader political critique is called for" (2016, 587). Counter-surveillance discourses, they argue, are disproportionately centred on technological solutions that address privacy issues rather than targeted surveillance. How, then, can counter-surveillance tactics challenge the technological elitism that frames these cryptographic solutions, seeking more equitable high-tech and low-tech solutions?

While we do not claim that counter-surveillance art can provide simple answers to the above questions, we argue that interactive artworks provide a unique experimental space in which these issues can be contended with and brought to light in new ways, and radical alternatives can be proposed. The work we have presented in this essay has seized upon these experimental opportunities, seeking the pedagogical potential of participatory art to draw audiences into a space in which they are directly implicated in entanglements between interactive enclosures and their subjects. We have argued that these sorts of interactive experimental deployments are uniquely effective in making visible the logic of ubiquitous of surveillance, and furthermore, in mobilizing audiences towards the consideration of counter-surveillance tactics in their everyday lives. The task of artists, in future attempts to tackle issues of ubiquitous surveillance, is to broaden the scope of these tactical experiments towards more comprehensive visions of a future in which populations are better empowered against the imposition of surveillance.

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Surveillance capitalism and the perils of augmented agency

Keywords
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philosophy of technology
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Over the last decades, a new form of economic system has emerged: "surveillance capitalism". Based on the extraction, appropriation, and commercialisation of increasingly detailed behavioural data but cloaked under the guise of personalisation, surveillance capitalism limits our privacy and our freedom of choice. This paper contends Big Tech organisations, the primary beneficiaries of the data-driven economy, are curtailing our capacity to self-transform, all the while promoting and generalising a false sense of augmented agency that perpetuates a lopsided and bureaucratic relationship with the world. This paper shows that a technologically informed philosophical reflection can help counter this state of affairs. It contends that a critical stance can help humans put themselves back on the feedback loop of technological mediation by helping us recognise our "becoming" with technologies as a design process.

1 INTRODUCTION

Early this year, an American plumbing company announced a new product: a (Amazon Alexa) voice-controlled "intelligent toilet" that promises a "fully immersive experience" thanks to ambient lighting, surround speakers, and heated toilet seat (Vincent 2019). This is another addition to the growing list of "smart" devices comprising the Internet of Things (henceforth IoT). The more formerly "dead" objects such as suitcases, toothbrushes, coffee machines, or rubbish bins become artificially enlivened and hence smarter[1] and capable of interacting with each other, the more our environment becomes *enveloped*[2]—and friendlier towards Big Data.3 That is to say, soon, potentially every object in the built environment could become an interactive node for the Internet and serve as a sensor gathering data about every minute detail of day-to-day human lives. This data is a potentially endless stream of information that will allow machine-learning and other AI methods to make more accurate forecasts about our behaviour and thus tailor services to the exact needs of each user. From a purely optimistic standpoint, this technological trend brings clear advantages to people, since hyper-personalisation will (positively) reinvent how we experience everything in our world, from shopping to education to health to entertainment (Lee 2018). Change, so it seems, is always good. Nonetheless, such state of affairs raises several serious questions about our relationship with technology at large and with so-called "Big Tech" in particular.

The rise of Big Tech "Data Barons" (Mayer-Schönberger and Cukier 2013, ch. 9) and their increasing power signals for some sociologists (Zuboff 2015, 2019; Naughton 2019) the emergence of "surveillance capitalism": a new economic system fuelled by data analytics guided by a radically new logic of accumulation that is curtailing human liberties and rights. Others (Graeber 2012) see the evolution of information technologies (IT) as a manifestation of the degree to which corporate bureaucratic culture has taken over society; as a deliberate effort to place "poetic technologies"[4] entirely to the service of "total bureaucratisation". Neither of these scholars sees ITs *per se* as being intrinsically responsible for these problems (that would imply endorsing some form of technological determinism), instead, they argue both technologies and their (mis)use have sociocultural origins. Some artificial intelligence (AI) researchers also recognise this need to focus on the human side (and responsibilities) in our relationship with technology, arguing that smart devices, even autonomous ones, are but tools that augment human capacities (Bryson 2009). Others (Edwards 2018, 23), argue that our societies have already become so deeply entangled in rapidly evolving Byzantine interacting ecologies of algorithmic feedback loops that we lack the conceptual tools to adequately describe and engage the complexity of our current sociotechnical systems.

This paper takes the previous situation as a starting point to argue that how current IoT devices are conceived is not only consolidating surveillance capitalism and total bureaucratisation but also fostering a false sense of *augmented agency*. It also argues that by automating mundane tasks

1. Some of the algorithms powering these devices, particularly those which "learn", are surely sophisticated, to the point of being "weirdly inhuman" (Berreby 2015), and this raises issues of grave concern. Nonetheless, it is important to note that for the time being, the "smartness" of IoT artefacts still depends largely on "mining" the growing streams of data generated by ubiquitous computing.

2. In the context of industrial robotics, the term "envelop" refers to the space within which a robot can effectively function (Floridi 2019, sec. 4).

3. There is no definitive consensual definition of Big Data, but it is useful to regard the term as a shorthand for the combination of (a) technical infrastructure (information processing hardware) and (b) processes/techniques for gathering, sorting, and querying vast volumes of data. The goal of Big Data is to discover previously unseen patterns, distil them into "predictive analytics" and apply that information onto new datasets (Yeung 2016).

4. In Graeber's own words, he is referring to "the use of rational and technical means to bring wild fantasies to reality"; "fantasies" here meaning the building of pyramids, exploration of Space, and transcontinental railroads.

and promising hyper-personalisation, IoT devices are generalising plutocratic, unimaginative interactions with the world, and in so doing they are curtailing our freedom of choice and our capacity to self-transform. Ultimately, this paper aims to show that philosophical reflection can be a powerful ally for developing a fruitful critique of our current sociotechnical systems. Namely, by providing conceptual design and the means for thinking about our relationships with technologies as haphazard iterative (i.e., design-like) self-transformation processes in which we have engaged since the dawn of human species.

The paper begins with an overview of surveillance capitalism and bureaucratic culture. This is followed by a summary of how contemporary philosophy of technology regards technological agency and its role in human life. Afterwards comes a brief account of the type of philosophical stance that might be best suited to provide adequate critical conceptual tools, before delving into an extended discussion of the main arguments. Given the complexity of the topics here discussed, this paper can only provide a modest initial assessment, further research and analysis are necessary to provide a more robust contribution to understand these issues.

2 THE AGE OF SURVEILLANCE CAPITALISM AND TOTAL BUREAUCRATISATION

Nowadays, the majority of the World's population uses ITs mainly to record and transmit data, and the economies in which they live are still dependent on industrial outputs, particularly those related to fuels and energy; these societies live "historically"[5] (Floridi 2012b). In contrast, some regions in the world have become "hyperhistorical", because their economies now depend almost entirely on the outputs of data processing. In these societies, computers have taken over virtually every other form of technology in an almost "zoological" fashion (Peters 2015); the built environment has thus been progressively enveloped through billions of sensors embedded within IoT devices. In these hyperhistorical societies, work has become overwhelmingly "computer-mediated" (Zuboff 2013). This is a radical shift because, unlike previous forms of mechanisation and automation, computers "informate", i.e., they generate data about when they are used, for what, and by whom, and thus make even the most minute detail about their usage knowable (Zuboff 2015). In contexts where computer-mediation has become pervasive, potentially every aspect of the world can be "datafied",[6] i.e., "rendered in a new symbolic dimension as events, objects, processes", thus making people and their behaviour "visible, knowable, and shareable" (2015, 78).

The vast amounts of data generated directly or indirectly by ITs at increasing speeds are collected, stored, abstracted, aggregated, and analysed[7] not only by "Big Tech" but by every new organisation wanting to take part in the contemporary economy. This usage of Big Data embodies a new logic of appropriation and accumulation underpinning the radically new economic system that Foster and McChesney (2014) and Zuboff (2015) refer

5. For a full description of the differences between historical and posthistorical societies see also Floridi (2014 ch.1). Floridi's concept is roughly equivalent to Flusser's ([1985] 2011) conception of "posthistory"; for a comparison see Galanos (2016).

6. As the coiners of this neologism argue, datafication differs from digitisation, insofar the latter merely involves turning an analogue signal into bits, whereas the former has explanatory and hermeneutical prerequisites arising from a desire to quantify, record, and interpret phenomena. For a critical view on datafication see van Dijck (2014).

7. Datasets may undergo various similar cycles; hence, once processed a dataset may be re-packaged by data brokers, sold, further analysed, and sold again (Zuboff 2015).

to as “surveillance capitalism”. Under this regime, organisations rely on data—particularly by harnessing so-called “data exhaust”—to forecast and modify people’s behaviour in order to generate revenue and gain further market control (2015, 75–80). Zuboff argues that contrary to what most literature seems to imply, Big Data is not an “inevitable” or “autonomous” “technological object, effect or capability”, but rather a socially-originated (pre) “condition and expression” of surveillance capitalism (2015, 75–76). In other words, although this economic system depends on Big Data, it was not the technology that brought it to life. Rather, surveillance capitalism was deliberately *invented* in the early 2000s by Google (2015, 80).

Taking advantage of its position as the most visited site on the internet and fearing that the fee-for-service paradigm would hinder its growth, Google give birth to contemporary data-driven personalised marketing. This new “auction-style” advertising model became canonical; the default business paradigm embraced by the emerging startup culture (Zuboff 2015, 76). In the years since, it has been adopted and refined by the remaining FAANGS[8] (Facebook, Apple, Amazon, Netflix, and Spotify) and by almost every other major technology company. Consequently, most organisations in hyperhistorical societies now deliberately design their services to extract as much data as possible from their users.

8. An alternative acronym, “GAFAM” privileges Microsoft in lieu of Netflix and Spotify.

This trend highlights a fundamental difference between previous economic systems and surveillance capitalism, and which according to Zuboff, is a hallmark of the latter: the utter “formal indifference” that organisations exhibit towards the people who are both their data sources and their targets. Google, for example, could not care less “what its users say or do”, so long as they do it in a way that Google can harvest the data (2015, 76–80). Under surveillance capitalism, there are no contractual reciprocities. Being automated, data extraction is a fundamentally unidirectional process; this leaves no space for negotiation or lawful relationships built on social trust, only for rewards and punishments based on opaque conditional decisions. People are presented with a “fundamentally illegitimate” “Faustian pact” (2015), whose scope and details they thoroughly ignore, thus agreeing to a ceaseless invasion of privacy in exchange for something they presumably want[9]—e.g., signing up for a service, such as a social network. Users willingly submit themselves to continuous surveillance in return for tailored and convenient services, this consent, however, often resembles that of the compulsive gambling addict (Yeung 2016, 131–32). The problem, as Zuboff notes, is that privacy implies deciding whether one wants to keep something secret or not, this involves *choice*. By “hypernudging”(see Yeung 2016) users into surrendering their ability to keep their information, their beliefs, and their wishes, Data Barons are curtailing their fundamental rights.

9. The problem, however, is that the “tech industry” often merely conflates “want” with “are more likely to click on” (Solon 2019).

The “formal indifference” characterising surveillance capitalism is symptomatic of the broader cultural shifts brought by more than four decades of gradual merging between private and public power in the name of profit—i.e., neoliberalism. Chief amongst these cultural changes is *total bureaucratisation:* “the imposition of impersonal rules and regulations [...]

backed up by the threat of force" (Graeber 2015, 32) over every aspect of daily life, in such a pervasive manner that people cannot imagine things could be done differently. As a result of this process, bureaucracy has become "the water in which we swim" (2015, 4) and every resource, particularly technological change (a.k.a. "innovation") has been put to the service of management. So although in the corporate narrative decision-making in private and public organisations increasingly prioritises creativity, reality shows the exact opposite is true. Instead of investing in technologies that could bring alternative, more egalitarian futures, organisations have prioritised the development of more sophisticated systems to further increase "labor discipline and social control" (2015, 120). Instead of addressing some of the challenges identified by Keynes ([1930] 2011) almost a hundred years ago, generalising a "four-hour workweek", building flying cars, and colonies on the Moon, we are have been left with infallible ATMs, high-frequency trading, and an enthusiasm for surveillance mechanisms that would put the *Stasi* to shame. What could otherwise be "poetic technologies" have become "bureaucratic technologies" (2015, 141). Rather than fulfilling the ideals of Ted Nelson (1974) or Stewart Brand, and freeing us from administrative responsibilities, software and ubiquitous computing have "turned us all into part or full-time administrators" (Graeber 2015, 140).

Free services provided by Data Barons are not objects of value exchange but "hooks" that lure unsuspecting users into an asymmetrical and indifferent form of technological mediation (Yeung 2016; Zuboff 2015). Voluntary submission into constant surveillance not only curtails our freedom of choice but erodes our capacity to self-transform because technologies in general, and these, in particular, do have tremendous influence over how we perceive the world, as we will see in the following section.

3 HUMAN "BECOMING" AND TECHNOLOGY

Traditionally, humanistic analyses concerning technological agency, including Critical Theory (in the "narrow" and "wide" senses (see Bohman 2016)) and early philosophy of technology (e.g., see Mumford 1967; Heidegger [1954] 1977), tended to regard technologies in pessimistic terms. They usually establish a sharp division between human nature and technics; portraying technology as a limiting, tyrannical, and overwhelming force constantly threatening to overwhelm human agency. In the last decades, however, there have been two important shifts in the way philosophy of technology conceives "being human". First, there is a growing acceptance of the artificiality of human nature; the realisation that, unlike other tool-wielding creatures, human beings actually "become constituted through making and using technologies" because tools shape our minds and augment our capacities (Ihde and Malafouris 2018). Secondly, there are increasingly more attempts to re-think our place in the world; to "re-place" human agency (Galanos 2017) and develop frameworks that account for the agency of non-human agents in our environment. Most contemporary posthumanist currents endorse, in varying degrees of strength both stances, including Actor-Network Theory (ANT), postphenomenology, speculative realism, new materialism, and informational structural realism, to name a few.

In light of the above, human evolution has been usually characterised in terms of adaptation, but our relationship with our surroundings is better described in dialectic terms, as a technically mediated "becoming". This means that as we actively transform our environment (for good and bad), our environment shapes us back. According to this "relational ontology", people and things are intrinsically linked (Ihde and Malafouris 2018). Hence, whereas other animals (e.g., great apes or ravens) are known to craft and use tools, arguably only the human *Lebenswelt* (lifeworld) is defined by a constantly evolving relationship with artificial objects (2018).[10] Fabrication, not only of tools but also of circumstances—to borrow Ortega y Gasset's ([1939] 1964) formulation—plays a central role in defining our species. Paraphrasing Flusser, thanks to technology we have gone from being mere mammals conditioned by nature to "free artists" ([1993] 2012, 19). In other words, it is not just that humans are outstanding makers but that such ability does not only involve designing and manipulating things but also determines when and how we change; how we self-consciously "become" (Ihde 2009). We humans, as Ortega y Gasset notes, are defined by our constant struggle to realise, to *make our existence:*

10. As Ihde and Malafouris (2018) further note, "the kind of minds we have depend on the kind of tools we make and use". This echoes Nietzsche's alleged claim that "our tools are also working on our thoughts" (in Kittler 1999).

> Man [sic], whether he wants it or not, has to create himself, to self-fabricate. This last expression is not entirely inappropriate. It highlights that man, at the very root of his essence, finds himself, first and foremost, in the situation of the technician. For man, living is, clearly and before anything else, the effort to bring into existence what there is yet to be.[11] ([1939] 1964, 341)

Technically mediated human becoming has arguably been going on for a long time, perhaps as far back as the time of Acheulean axes (roughly 1.7 Myr ago). However, in the last decades, our world has become friendlier towards technologies that have increasingly more agency, autonomy and, therefore, can have a stronger influence over human actions and decisions. As Floridi notes, these artefacts are "inflexible, stubborn, intolerant of mistakes, and unlikely to change"; whereas humans tend to be exactly the opposite, and yet we are becoming more dependent on them. The problem is that as our dependency increases so does the possibility that our technologies end up calling the shots; distorting and constraining our behaviour and "our physical and conceptual environments" to further accommodate us to them instead of the other way around. The danger is that instead of establishing healthy dialectic relationships we end up adapting to *their* "needs" simply "because that is the best, or sometimes the only, way to make things work" (2012a, 252–53). Examples abound where things have to be done in cumbersome ways to accommodate the use of a given technology, even if we no longer notice it—we only need to

11. Author's translation; the original text is as follows: "El hombre, quiera o no, tiene que hacerse a sí mismo, autofabricarse. Esta última expresión no es del todo inoportuna. Ella subraya que el hombre, en la raíz misma de su esencia, se encuentra, antes que en ninguna otra, en la situación del técnico. Para el hombre, vivir es, desde luego, y antes que otra cosa, esforzarse en que haya lo que aún no hay".

think about how the adoption of motor vehicles has conditioned human movement and urban planning at large.

Choosing which technologies we incorporate in our lives is a crucial matter since they play a crucial role in our self-design (Pitt 2011). The problem, however, is that we lack a method or framework to do so beyond simple heuristics because we cannot know in advance (only speculate) how a given technology will affect our lives in the long term. The problem is made worse because we are being surrounded by an increasing number of sophisticated systems that are specifically designed to influence our behaviour. As noted at the beginning of this paper, philosophical reflection, particularly one that is grounded on action and informed by a broad understanding of technological agency can help us tackle these issues. It can provide an approach for understanding how to deal with our technologies and the world they help us make, and hopefully, provide a basis to steer things into a better direction.

4 PHILOSOPHY IN ACTION

Philosophy is at worst regarded as a discipline concerned with Byzantine discussions, and philosophers as people who endlessly argue about things that matter only to a reduced group of specialists—hence the constant calls by the managerial class[12] to stop wasting resources on philosophy. At best, philosophy is regarded (in the West) as a discipline concerned with teaching the history of ideas that emerged some 2,500 years ago and formulating responses to them following a rigorous method of thinking. Both views assume that "the landscape" (Pitt 2011) of philosophical practice has not changed in over two millennia, and it would be easy to dismiss them as little more than caricatures. Nonetheless, there is at least some truth behind such views, philosophy, like any other discipline, can certainly become "scholastic" (Floridi 2011).

12. To be fair, bureaucrats are not the only ones debasing philosophy, demagogues and even scientists often assume similar stances. Stephen Hawking's (2010) infamous claim stating that "philosophy is dead" because it is outdated is an excellent example of the disdain that some otherwise brilliant people have for this field.

Scholastic philosophy is conservative, institutionalised in the worst sense, and bureaucratic in its blind and inflexible imposition of form, goals, and procedures. Scholastic philosophy "manifests itself as a pedantic and often intolerant adherence to some discourse" (Floridi 2011, 9) established and perpetuated by a given group of specialists. These specialists tend to be "metatheoretically acritical" (2011, 9); they only care for the ideas of their community. A philosophy like this is a closed system; it ignores other disciplines, and it is unconcerned with reality and the events and developments outside of its domains. Scholastic philosophy is merely concerned with "perennial questions", issues that, it assumes, remain unchanged and unaffected by history. Luckily, such is not the kind of philosophy that interests us here. The kind of philosophy or at least the approach to philosophy that concerns this paper is one moved by a deep interest in how human contexts, practices, ideas, and relations have changed in the last decades due to technological shifts. Such is a philosophy concerned with consequences and actions; it is a philosophy that, to use a borrowed formulation, responds or reacts to social change, not one that regards the self as a motivating force in and of itself (Pitt 2011, 3:46)

The philosophical approach that interests this paper is one that concerns itself with "how best to make it through the muddle that is life" (Pitt 2011, viii), and this involves understanding what is "out there". The ultimate goal of this enterprise is normative, but it proceeds by creating "dangerous ideas", ideas that "threaten the status quo" by instilling doubt, "ideas that motivate people to do something" (2011, ix). This philosophy assumes technologies are deeply transformative and therefore seeks to understand how by being exposed to them we humans change the world and ourselves in the process. Doing this kind of philosophy means something like the following:

> seeking wisdom with respect to the world we have built, by seeking out all the accompanying epistemological, normative and metaphysical questions that world and what we do to create it and act in it raises. (Pitt 2011, xii)

In other words, this philosophical approach aims to understand how to best live in the built environment, but also to trigger some form of change within it; it is pragmatic: it insists there should be some "difference in conduct resulting from philosophical ruminations" (2011, xiii).

A philosophy that rejects scholasticism and perennial (ahistorical) questions is "not in the business of discovering solutions but in that of *designing them* [emphasis added]" (Floridi 2013b, 211). It is a philosophy that deals necessarily with open questions; that is, questions that are by their very nature susceptible "to reasonable disagreement" (2013b, 216). Moreover, it does so iteratively. It can begin by looking at the world and formulating new open questions and design new answers for them or, in the light of new developments and information provided by other disciplines, it can revise old questions that remain open and design new answers. It is a timely enterprise that relies on a feedback loop with the world around it: "[l]ike a living heart, philosophy goes through a cycle of systole and diastole, contraction and dilation, outsourcing and insourcing of problems and solutions" (2013a, 215). It is a constructive enterprise that begins by analysing open questions as a preliminary stage before designing satisfactory answers for them (2013a, 2018). "Satisfactory" meaning, the point after which any further discussion is superfluous (Flusser [1991] 2014).

A philosophy like this can help us understand technologies as ontological tinkering devices, but it also can help us to build a well-grounded criticism of surveillance capitalism and the way it is affecting human life.

5 DISCUSSION

5.1 The illusion of augmented agency

Surveillance capitalism and the type of technologies it is fostering are fundamentally bureaucratic. Bureaucracy is, by definition, arbitrary, inflexible, alienating, inefficient, and taxing (in the broad meaning of the word); and it is also underpinned by the threat of violence (Graeber 2015). Nonetheless, bureaucratic procedures are often justified by claiming they will achieve precisely the contrary: that they will make processes cheaper, expedite, meritocratic, and transparent. Bureaucratic procedures replace organic tête-à-tête negotiation and bargaining (which presupposes some form of symmetrical relationship) with reductive, generalised, imperatives (grounded on hierarchies and asymmetries) that follow the simple formulation "if, then, else". Bureaucracy is, above all, unimaginative.

To the best of our knowledge, humans have the unique capacity to picture things in their mind's eye; consequently, we can project our ideas and ourselves into hypothetical past and future scenarios. This means that unless we have some damage in our frontal lobes, we can put ourselves in other people's shoes and imagine what it would be like to stand in their position. This requires interpreting, understanding, and (to varying degrees) caring for other people, their circumstances, and needs. Bureaucracy, on the other hand, is imposed as a remedy against the above; as a substitute for the myriad exchanges people are required to carry out every day when interacting with other people and institutions.

Bureaucratic procedures are imposed to manage relationships that are already extremely unequal in terms of interpretative (empathic) labour. Bureaucracy embodies and institutionalises "lopsided structures of the imagination". Thus, bureaucracy is not so much an embodiment of stupidity but a way to manage circumstances that are stupid *because* there are preexisting inequalities underpinned by structural violence (Graeber 2015). As everyone knows, power allows people to behave crassly towards other people. As Graeber (2015) notes, "[p]ower makes you lazy"; people in a situation of power and privilege often unabashedly avoid engaging in imaginative identification, particularly towards those whom they regard as their inferiors. Attempting to imagine how their subordinates feel is nothing short of a burden, after all, "in most ways, most of the time, power is all about what you don't have to worry about, don't have to know about, and don't have to do" (2015, 101). Imaginative, emphatic, and caring labour is usually the responsibility of people serving those in the upper echelons of society. After all, servants are people who have to anticipate the needs, desires, whims, and moods of those in power, whereas these, in turn "can wander about largely oblivious to much of what is going on around them"(2015, 81).

The current trends in IoT consumer technologies seem focused on generalising precisely such bureaucratic/lopsided attitude towards the world. Only this time the interpreting labour is carried out by smart devices. The emergence of various AI personal assistants (Alexa, Google Assistant, Siri, and Cortana) and smart environments (e.g., Kohler's Numi 2.0 or Whirlpool's smart kitchens) exemplify such trend. Smart, voice-controlled systems that unlock doors, regulate temperature and lights, play music or do our laundry simulate the kind of relationship plutocrats have with those around them. As Zuboff (2015, 84) notes while discussing Googles' strategies, tech companies seem poised in transforming the luxuries of the priv-

13. Here, agency is broadly understood as the capacity of an agent to bring about specific changes in the world; which implies the agent can decide to act (or not), choose to do it in a certain way, and execute the action (see Bunnin and Yu 2009).

ileged into affordable necessities for the population in the lower strata of society. This privileged augmented agency[13] (having one's whims satisfied by an artificial agent at the sleight of one's hand), however, comes at a cost that far exceeds the benefits.

These systems can potentially realise such (distorted) utopia not because they are as prescient as the Ferrero Rocher chauffeur but, as was earlier discussed, due to the massive amounts of data they can access. For the plutocrat the underling is disposable and easily replaceable; regardless of how intimate or longstanding their relationship might have been, there is no doubt who holds the power. Conversely, the power (and liberty of choice) the average Joe has over his growing network of Alexa-controlled devices is, at best, illusory. What might seem as an innocuous indulgence is, in reality, based on a "Faustian pact" (Zuboff 2015). Using an Alexa-controlled musical toilet that lifts its cover and washes and dries one's rear end grants Amazon the possibility of, say, creating a schedule of one's bowel movements and selling it to data brokers for whatever purpose. This is no Jedi telekinesis but a false consciousness sense of augmented agency. It is not personalisation but encroachment, the kind that only an extremely efficient bureaucrat can carry out.

5.2 Bureaucratic technologies are hindering human self-transformation

Surveillance capitalism and bureaucratic technologies are not only generalising a false sense of augmented agency; they are hampering human self-transformation. Previously, we saw that from the perspective of philosophy of technology, a defining feature of human beings is that we self-fabricate our lives, that we can regard our existence as a technical enterprise or rather, as a design process. Designing is an activity concerned with problem-solving, planning and projection, but its defining feature is *iteration*, its reliance on feedback loops. Machines and tools are objects conceived "to defeat the world's resistance" (Flusser [1991] 2014, 14), to overcome our "natural" limitations by augmenting or enhancing our physical or cognitive capacities. As intrinsically artificial creatures, we are the sum of the technological enhancements we choose to incorporate in our lives (Pitt 2011), and these include everything from our means of transportation to our clothing and entertainment. We are our technologies. As we progress in life, we experiment, we tinker with myriads of such choices, we test and see whether they fit in our lives and contribute or not to what we wish to become. Ideally, throughout this process we make adjustments and corrections, we engage in a feedback loop, not unlike those characterising every design project. This formulation assumes that we have not only the capacity to choose but the means to evaluate our choices. However, in this age, this situation is becoming the exception rather than the rule.

Under the guise of customisation/personalisation, bureaucratic technologies are curtailing human freedom of choice—all the while instilling the sense that we have too many choices, as the "FOBO" phenomenon suggests (Reagle 2015). Through the appropriation of user's behavioural data, which companies regard as a free-range resource "for the taking", to create tradable "prediction products" (Zuboff 2019), most tech companies relying on Big Data aim to manipulate user's decisions. As noted earlier, the economic model pioneered by Google has been adopted not only by FAANGS, but by virtually every other company selling insurance, healthcare, retail, entertainment, education, finance, and other services (2019). As Zuboff suggests, any IoT product currently labelled as "smart" is either already playing a role in the behavioural data supply-chain or is capable of doing so. Major companies and data brokers are constantly working their way to circumvent obstacles against data collection, including users' explicit rejection; for example, by gathering inference data from public sources and users' unrelated activities—particularly from so-called "data exhaust". Under such conditions, users do not have access nor control over their behavioural data and how it is being interpreted and for which ends. As Zuboff points out, we are not only being "exiled" from our own behaviour but from the "knowledge" it yields (Naughton 2019). This circumstance highlights yet another divide characterising surveillance capitalism: an asymmetric relationship between those who know (but hide behind inscrutable and often dangerously biased "algorithms") and those who are known and for whom privacy is a luxury, not a right.

Resembling "the social relations of a pre-modern absolutist authority" the logic of surveillance capitalism deprives populations of their capacity to choose which information about their lives remains undisclosed. It follows that "[w]hat is accumulated is not only surveillance assets [data and the technical means to handle it] and capital, but also *rights* [emphasis added]" (Naughton 2019). Zuboff's characterisation of surveillance capitalism's appropriation and exploitation of informational resources draws heavily on geographic metaphors that echo the plundering of the so-called New World.[14] Nowadays, however, the territory being claimed is what Floridi (2007) calls the "Infosphere": the expanding environment inhabited by humans and other informational agents resulting from the merger of our physical world and our "onlife".

For companies driving the new economic system, it is no longer enough to automate information flows about their users but to automate their behaviour. They meticulously design these processes to guarantee the users' ignorance, to hamper their awareness, their decision-making and hence, their self-determination. Organisations go to great lengths to "engineer the context around a particular behaviour and force [the user to] change that way" (Naughton 2019). As the world becomes more enveloped, we find ourselves ambushed continuously by nudges;[15] our decisions micromanaged, our choices engineered. When the circumstances are so lopsided, it is evident that it is no longer us who hold the power to design ourselves, to tinker with and explore other possibilities of being-with-technologies, we are being denied access to the feedback loop.

Neither bureaucratic technologies nor surveillance capitalism could have existed without ITs. However, whereas surveillance capitalism

14. As Zuboff notes, as surveillance capitalism becomes more visible, the term "digital native" acquires a somewhat ironic overtone.

15. As Yeung (2016) argues, because Big Data analytics can be updated continuously and tweaked they are a far more powerful means for nudging (i.e., "hypernudging") than the one initially advocated by Thaler and Sunstein (2008).

and respect for privacy are fundamentally incompatible the emergence of services designed with privacy in mind is proof there is an economic alternative to Google's "free" surveillance assets. In these days and age, *we are* our information and what becomes of it (Floridi 2014). Since technologies hold such power over what we are it is vital to imagine ways in which we can establish a healthier, freer relationship with them. But first of all, we ought to question and challenge the inevitability that surveillance capitalism has attached to ITs. Philosophical enquiry can play a decisive role in this respect.

5.3 Philosophical thinking as conceptual design

Bureaucratic thinking (purely concerned with procedures) has taken over our relationship with technologies, and hence over our capacity to change according to our own designs. Our bureaucratic technologies are hypernudging us; they attempt to program us, to micromanage us, to steer us, to predict us, to construct us. Hence, in our daily struggle to change the world (to work) we now hardly ever question the "what's" and "why's" of our activities and focus merely on the how's, to borrow Flusser's ([1991] 2014) formulation. As it is currently being developed, the promise of automation is not one that brings more leisure time, a healthier, safer, environmentally sound, and egalitarian society where human autonomy is nurtured for good. Instead, the reality that surveillance capitalism is achieving involves the expansion and perpetuation of the lopsided, unimaginative relationship of the plutocracy with the world around them, with few if any of the "benefits". Arguably, then, we need some way to challenge this status quo. To reclaim the role of our technologies from bureaucracy and turn them once again into poetic tools. That is to say, to use bureaucracy and technologies "to bring wild, impossible fantasies to life" (Graeber 2015, 141).

What we are missing is ways to imagine different relationships with our technologies but also the means (concepts) to talk about our shifting circumstances. As Zuboff herself notes, whenever we confront the unknown, the first task one needs to carry out is naming, for "naming is the first step toward taming" (Naughton 2019), we need insights about the true nature of the phenomena that is changing our world in such radical ways. Criticism such as Zuboff's and Graeber's provide a sociological framework for contextualising our critique, but something else is also missing: the capacity to imagine how things could be different. Technologically informed philosophical reflection understood as conceptual design, might take us a long way into that objective.

Philosophical thinking, as we saw earlier, is precisely in the business of doing the above, of creating "dangerous ideas" by instilling doubt. Doubt presupposes that things could be different than they are, that it is reasonable to think we could change our circumstances. Philosophical reflection can take us back to the feedback loop, by looking at technologies critically, by asking questions about their reason to be and our reasons for adopting them. Philosophical reflection can also help us frame our own echnologically aided becoming as an iterative process and thus to reclaim our responsibility by helping us see that technologies are not just things that happen to us, but things that we ought to decide whether or not to incorporate in our lives. Practising philosophy does not mean questioning out of mere idleness, but (ideally) to trigger some form of change. To put it in Floridi's terms, "philosophy is not a conceptual aspirin, a superscience, or the manicure of language. Its method is conceptual design, that is, the art of identifying and clarifying open questions and of designing, proposing, and evaluating explanatory answers." (2016, 218).

6 CONCLUSIONS

Surveillance capitalism and the type of technologies that is fostering are fundamentally bureaucratic. Current trends in IoT consumer services are generalising a false sense of augmented agency that mimics the lopsided, unimaginative and careless relationship plutocracies establish with the world around them. Promising to transform the seemingly innocuous laziness of the powerful into an accessible necessity, bureaucratic technologies are forcing people into nothing short than Faustian pacts. By incorporating systems designed to extract as much behavioural data from them to predict and influence their behaviour, users of bureaucratic technologies are surrendering their capacity to self-transform; to develop as individuals. Bureaucratic technologies are alienating users from their own experiences, from the uncertainties that help nurture feedback loops. However, this is not the only way in which ITs can or should operate.

Throughout this paper, the goal has been to argue that philosophical thinking and questioning can serve as a valuable tool against the bleak future that expects us should we allow surveillance capitalism to go unchecked. Philosophical thinking instils doubts, but it also contributes to the design of conceptual tools to address current technological changes. Philosophy of technology provides a critical framework, one that is not marred by a sterile Luddism, that recognises that technologies are multistable, not intrinsically good or bad (with certain exceptions), but a fundamental component of human nature. The analysis here offered is currently at an initial stage. There is much work to do, but recognising the power of technology and the role of design in our lives is just a small initial step.

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Data (self) Portraits: an Approach to the Visualization of Personal Data from an Autoethnographic Perspective

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This study aims to explore the creative possibilities associated with the concept of data portrait as a means of representing and expressing identity. To this end, it begins by discussing the concept, its emergence, and the functions of data portraits. It then examines its concrete manifestations by analyzing a set of aesthetic artifacts that are, implicitly or explicitly, tied to the notion of data portrait through different creative approaches. This analysis informs the design and development of a *Data Self-Portrait,* aiming to explore visualization methods for producing a portrait, generated from personal data collected through an autoethnographic approach. In this manner, this study seeks to highlight how personal data become relevant in portraying identity. It seeks to contribute to a discussion about the ways of conceptualizing portraiture, informed by the current proliferation of digital data and the creative possibilities offered by computational media for exploring the portrait as a representation genre.

1 INTRODUCTION

The portrait as a symbolic representation of individual identity tends to reflect the social, cultural and technical contexts in which it is created. In the current moment characterized by omnipresent technological mediation, data portraits appear as forms of portraiture that propose to evocatively represent the identity of individuals, being based on personal data generated as a by-product of daily activities and registered by technological devices of everyday use. These data sets function as a kind of fingerprint, unique to each individual and, given this expressive potential, are used as raw material for the construction of portraits.

The notion of data portrait then emerges as an outcome of creative practices that explore the concept of identity by using visualization methods to value and give an expression to personal data, as an index of the real and as a record of personal experiences.

This study seeks to explore the creative possibilities associated to this notion as means of representation and exploration of individual identity. To this end, it combines a theoretical, analytical and projectual approach, proceeding to a discussion of the concept of data portrait that guides the selection and analysis of a set of works, from which we extract guidelines for the design of a *Data Self-Portrait*, as a reflection and expression of one's own identity. In this manner, it also suggests how portraiture can be conceptualized, as is informed by the current context of proliferation of digital data through computational means.

2 DATA PORTRAITS

The notion of data portrait refers to forms of portraiture that evocatively represent the identity of an individual based on accumulated personal data. According to Donath (2017, 187), data portraits are "depictions of people made by visualizing data by and about them". So these portraits do not represent faces. Their visuality is the product of the quantification and representation of data produced in the course of daily experiences and registered by technologies of personal use.

These portraits take advantage of our contemporary mode of online information consumption and socialization, and of the vast amounts of data that are generated in this process and that constitute our digital footprint, be it data resulting from common daily activities, such as online searches, geo-location, or arising from various interactions with technological devices that collect biometric or environmental data. However, this is not always the result of a deliberate action, but rather a consequence of our daily routine, given that data about us are produced, whether we are aware of it or not. These registers extend in time, reaching the past, and mapping the evolution of our identity to the present, as potential biographical repositories.

Therefore, central to the design of data portraits is the subjective decision of which data to choose and what to show, so that the portrait becomes a relevant representation of the individual in the contexts in which it is produced and circulates. Accordingly, the visuality of these portraits is no longer the result "of the form of a phenomenal world, with its faces, its landscapes, its events", but rather "of the elemental multiplicity constituent of a nebula of data that a screen interface will distribute and will organize in matrices of luminous points under a purely conventional legislation of discursive organization" (Renaud 2003).

2.1 How data portraits emerge

The first notable experiences around data portraits emerged in the late 1990s, associated to the need of creating representations of participants in online discussions. Within these groups, profile pictures are of limited value since the most relevant information about the users relates not to their appearance but to their actions within the group itself. Responding to this, visualizations were created as a means to map each user's activity and to help group members make sense of each other (Donath 2017, 198).

The *PeopleGarden* project (1999) was one of the first data portraits developed by Rebecca Xiong and Judith Donath, at the Sociable Media Group of the MIT Media Lab. Chosen for its "simplicity and intuitiveness" the garden metaphor was used to represent participants in an online discussion forum, wherein organic forms, similar to flowers, conveyed how the users behavior can change over time, as a "simple object that can easily deal with a changing number of components" (Xiong and Donath 1999).[1]

In this manner, these data portraits represent a cultural and ideological shift concerning the representation of identity, with direct implications on portraiture as a representation genre. While depictions of faces can convey relevant social information, such as age, gender, ethnicity, these portraits prioritize the representation of "qualities that are not directly observable", relating to actions, behaviors and ideas, as socially relevant information that cannot be directly deduced from appearance (Donath 2001). Thus appearance loses its value and significance to the expressive potential of data as a raw material for portraiture.

1. The height of each 'flower' refers to the period of the person's relationship to the group, the number of 'petals' indicates their number of contributions and the color expresses how recent are their interactions with the group. As the authors explain, "We wanted a simple object that can easily deal with a changing number of components. We also like the organic nature of a flower, and the suggestion that it changes over time, as users do. (…) We have used the garden metaphor because a healthy garden has certain properties that we can use to represent a healthy discussion group. For example, a garden with more bright flowers indicates a discussion group with more new posts" (Xiong and Donath 1999).

2.2 Functions of data portraits

Although different from traditional portraits, data portraits evoke functions of their classic counterparts as essentially tied to the representation of the subject before the other and/or before himself. On one hand, they can fulfill a 'proxy' function by representing individuals in online communities, revealing their behavioral patterns to the communities and having an impact on how others act towards them. On another hand, data portraits can act as a "data mirror, a portrait designed to be seen only by the subject, as a tool for self-understanding" (Donath et al. 2014). As a vehicle for the self-exploration of identity, the portrait becomes a 'data mirror' or a self-portrait reflecting patterns of behavior.

Data portraits can also fulfill a political role by drawing attention to the loss of privacy and control over one's private information. As digital surveillance becomes increasingly ubiquitous, they also entail the re-appropriation of personal data dispersed in the Big Data domain, by returning them to the private and domestic sphere of the small data universe. Such is the case with Jason Salavon's *Spigot* (*Babbling Self-Portrait*) (2010), as a mapping of the history of his personal searches, which Google kept on file.

Finally, and according to Lupton (2016), data portraits can also promote an affective tie with one's personal data, as an effect of their instantiation. When represented, data acquire a symbolic value that can generate feelings of belonging associated to the notion of identity. They can have a similar effect as photographs exhibited in a house, acquiring biographical and therefore sentimental value, tied to their documentary nature and to their role of replacing that which is absent, thus being regarded as crystallizations of moments, of past experiences.

2.3 From portraits to data portraits

We can define data portraits as forms of portraiture, or artistic constructions, that represent the identity of the subject portrayed and that commonly resort to autoethnographic methods for collecting relevant data, which is quantified and given expression by means of visualization techniques. In this process, computation can play a role in automatizing the mapping process, or in assigning dynamic properties to the visualization. The resulting artifacts can be considered as an outcome of an interdisciplinary practice, when taking into account the different concepts and approaches involved.

The portrait

Accompanying technological and cultural advances the portrait has been gradually reinvented following the tendency to detach itself from the mimetic representation of the physical body and moving towards abstraction. For example, *Portrait of Deb from 1988-199?* (2012-2013) by L. J. Roberts, seeking to defy strict binary conceptions of gender and approaching their impact on identity, was conceived from a series of embroidered emblems collected by Deb. As a form of physical data portrait, the work is based on the notion that material objects express meaning, and employs enumeration techniques and personal inventory as a form of portraiture.

This use of enumeration techniques and personal inventory allows the same kind of exploration of identity that characterizes the conventional portrait, however shifting "attention from iconic qualities of portraiture to indexical ones" (West 2004, 212). It thus provides a conceptual ground for the emergence of new forms of portraiture where autoethnography plays a role.

Autoethnography

The autoethnographic approach can be characterized by an hyper-observation of daily life, through data collection and documentation; a basis for producing aesthetic artifacts by means of self-observation.[2] These artifacts

2. For example, Sophie Calle can be regarded as a "self-styled ethnographer of the everyday" who uses ethnographic techniques to make art "out of her own and other's lives," based on "processes of hyper-detailed observation and data gathering, using complex strategies of surveillance, reportage and documentation" (Morely 2007, 100).

then propose a reflection on the identity and daily life of the subject by using documentation processes and appropriating techniques from the scientific disciplines, such as exhaustive observation, data collection, quantification and inventory (Morley 2007, 100).

Considering that routine is so embedded in our day-to-day life that we tend not to pay any attention to it, Morley (2007, 96-97) argues that the question "is not to discover the new, the grandiose, the striking, the exceptional or the unexpected, but rather to (re)discover or perhaps see well for the first time, the realm of that which is already familiar and, thus, largely unseen"; in other words, to pay attention to "what is truly daily in our daily lives" such as the banal events that constitute almost the whole of our existence.

Following a process of "reflexive self-observation", the autoethnographic approach highlights the use of personal experience to generate knowledge, not only about the self, but also about culture (Bochner and Ellis 2016). This idea conforms to Perec's suggestion that "What's needed perhaps is finally to found our own anthropology, one that will speak about us, will look in ourselves for what for so long we've been pillaging from others. (...) Not the exotic anymore, but the 'endotic'" (Perec 1999, 210).

Data

These processes of self-observation are based on capturing facts and occurrences by collecting data, which can be understood as a "set of measurements extracted from the flux of the real" (Whitelaw 2008). However, ontologically, data can be seen as an abstraction that only becomes meaningful when organized and contextualized in order to convey information.[3] As such, data is a "broad term that refers to collections of values that help us understand a phenomenon more deeply" (Freeman et al. 2016).

When we talk about personal data we are commonly referring to any information relating, directly or indirectly, to an identified or identifiable individual, be it by reference to a name, identification number, biometric data, fingerprints, DNA, or other factors specific to their physical, physiological, mental, economic, cultural or social identity.[4] So the notion of personal data can include a diversity of measurements collected through autoethnographic methodologies, which are tied to aspects of the everyday life of individuals, pertaining to physical or physiological realms.[5]

The current trend toward quantifying all aspects of one's daily life is also enhanced by the growing ubiquity of self-tracking technologies. An expression of this trend is the *Quantified Self* movement,[6] which takes advantage of the possibility of digitally recording personal experiences, by automatic or semi-automatic means, and archiving these highly individualized data sets that can function as biographical repositories, whose analysis would possibly contribute to optimize our potential as human beings.

In this sense, personal data always emanate from the concrete world and, therefore, shouldn't be regarded as complete abstractions because they arise from material aspects and physical actions that reflect people, with their idiosyncrasies and subjectivities. Data portraits thus challenge

3. As Whitelaw (2008) explains, "In themselves, such measurements are abstract, blank, meaningless. Only when organised and contextualised by an observer does this data yield information, a message or meaning."

4. According to the *General Data Protection Regulation* (EU Publications 2016).

5. Namely, personal data can be relative to an individual's actions (communications, activity in social networks), consumption habits (food, quality of surrounding air), mental states (moods, excitement) and performance (heart rate, oxygen levels in the blood).

6. The term Quantified Self (QS) "embodies self-knowledge through self-tracking" referring to a number of aspects we can measure about ourselves such as, "our heart rate, respiration, hours slept, or even the number of sneezes and coughs during a day. However, not all important things in life can be measured and not everything that can be measured is important. QS really revolves around finding personal meaning in your personal data" (Quantified Self Institute 2016).

the impersonality of data as an abstraction, revealing how data can be recovered from the Big Data realm and brought back to the personal sphere; how it can be used to create visual narratives that are able "to connect numbers to what they stand for: knowledge, behaviors, people" (Lupi and Posavec 2016).

Visualization

These forms of portraiture however tend towards visual abstraction, as a means of visualizing subjectivity and as visualizations of a subjective nature. The mapping of abstract quantifications (of a subject's traits and activities) into visual representations enables the creation of form from that which is formless, in order to make it perceptible, intelligible and interpretable.[7] So visualization is often about "rendering the phenomena that are beyond the scale of human senses into something that is within our reach, something visible and tangible" (Manovich 2002).[8] Therefore, subjectivity is also inherent to the choices involved in the mapping process. In this sense, and as suggested by Manovich (2002), "data visualization artists should also not forget that art has the unique license to portray human subjectivity."

This high degree of subjectivity can nevertheless be coupled with a notion of Realism. In particular, we can invoke what Min (2015) refers to as 'digital realism', considering that "Digital data is, to a certain extent, pure. At a surface level, there is no fantasy or illusion in the data world" (Min 2015). The role of visualization would therefore be to allow a direct access to 'reality' through a visual rendering of data extracted from the 'real' world. The image is the result of the conversion of data into a symbolic system; it arises from the discursive organization of the data according to a code. As such, it can be considered a direct result of the data and therefore hyper-realistic.

7. The process of deriving information from a given data set, as described by Fry (2008, p. 5), implies the obtention of that data (*acquire*), structuring them (*parse*), the usage of methods of quantitative analysis such as statistics (*mine*), its representation according to a visual model (*represent*), the refinement of the same representation in order to make it clear and visually appealing (*refine*) and, finally, the integration of interactive features that allow viewers to select data and control how it is displayed (*interact*).

8. Complementing this idea, Manovich (2002) states "data visualization art is concerned with the anti-sublime. If Romantic artists thought of certain phenomena and effects as un-representable, as something which goes beyond the limits of human senses and reason, data visualization artists aim at precisely the opposite: to map such phenomena into a representation whose scale is comparable to the scales of human perception and cognition."

The role of computation

When considering computationally produced images, Renaud (2003) designates them as "informational images" since their form is a direct result of the conversion of data (numerical quantities) into something "sensible" or "visible". But its "numerical" (digital) nature also constitutes an "operative informational visibility" potentially endowing it with new functionalities. The creation of these visualizations then relies on computation to enable the translation of data into static or dynamic images, as different instances of a class of images resulting from algorithmic processes. As Antonelli (1999, 11) points out, the instructions or algorithms reveal a "programming method that transforms itself into a visual design process", and this can also involve endowing the image with dynamic features or enabling the interactive exploration of visual representations of data.

3 ANALYSIS

In order to understand the diversity of creative approaches to the concept of data portrait, we analyze a set of projects that are implicitly or explicitly tied to this notion, in the light of the previous definition. We selected works that use personal data as raw material, employ quantification processes, assign a visual expression to the data and address issues related to identity. The diversity of data used, the mapping processes employed, the multiplicity of modes of expression and representation, as well as the variety of media, were also valued in order to understand the diverse manifestations of data portraits.

The selection of works is listed chronologically:

1. *DNA Portraits,* DNA11, 2005;
2. *Spigot (Babbling Self-Portrait),* Jason Salavon, 2010;
3. *201 Days,* Katie Lewis, 2010;
4. *TimeMachine,* CADA, 2012;
5. *Mood Maps,* Erin Hedrington, 2013-2014;
6. *Heart Bot,* Odd Division & Tool of North America, 2014;
7. *Data As Object,* Brendan Dawes, 2014;
8. *The Art of the Thrill,* Sosolimited, 2014;
9. *Walking,* Laurie Frick, 2012-2015;
10. *Data Portraits,* Kristin McIver, 2015;
11. *Dear Data,* Giorgia Lupi & Stefanie Posavec, 2015;
12. *The Sixth Sense,* Clever Franke, 2016;
13. *Poisonous Antidote,* Mark Farid, 2016;
14. *HeART of Travel,* Joshua Davis, 2017;
15. *Halo,* Peter Crnokrak/ ORA, 2017;
16. *The Art of Feeling,* Random Quark, 2017;
17. *Floating Map/ Latitude and Longitude Project,* Stephen Cartwright, 1999 - in progress.

3.1 Model of analysis

In order to highlight what features these works share and how they diverge, the analysis follows the dimensions proposed by Ribas (2014) concerning digital computational systems as aesthetic artifacts,[9] while incorporating the subcategories that Lee (2014) defines around this model, considering *concept* (theme and content), *mechanics* (data and mapping processes) and the elements of *experience* (surface and dynamics).

We also took into account how Donath et al. (2014) and Lupton (2016) define the functions of data portraits (perception of patterns in personal data, aggregation of scattered digital data, exploration of the affective dimension of data and representation of the individual within a community). We also resorted to the taxonomy by Freeman et al. (2016) regarding data as raw material for the production of aesthetic artifacts, and Kitchin and Lauriault (2014) differentiation between Big Data and small data. Additionally, we considered how Whitehead (2005) discusses the ethnographic value of the various types of data, while Selke (2016) distinguishes between passive and active, deliberate and non-deliberate methods in data collection.

On a conceptual level, we analyze the theme and functions of the data portrait, considering the type of personal data used, its source, degree of privacy, scale and autoethnographic value. At the level of mechanics, we

9. Its focus on the creative use of data and processes is defined on the basis of the MDA framework (Hunicke 2004) and the model for digital media proposed by Wardrip-Fruin (2009) and the focus on processes defined by Dorin et al. (2012).

examined data (collection methods, the time of data collection and dataset assembling) and mapping processes (from input methods to mapping process and reference systems used to graph the data). Concerning experience, in terms of surface we focused on output media, modalities of expression, abstraction to the referent, legibility of information and the role of color. The dynamics concerns the type of results, overall behavior of the output and the level of interactivity.

3.2 Observations

Theme and content

Many of the works analyzed highlight the *perception of patterns* in data arising from personal data, often associated with an exploration of the *affective dimension of data*, by using personal data relating to the subject's actions or *biometric* data. The political dimension of *aggregation of personal data,* relating to its re-appropriation by the subject, is also at stake, as is the case of *Spigot (Babbling Self-portrait)* or *Poisonous Antidote*.

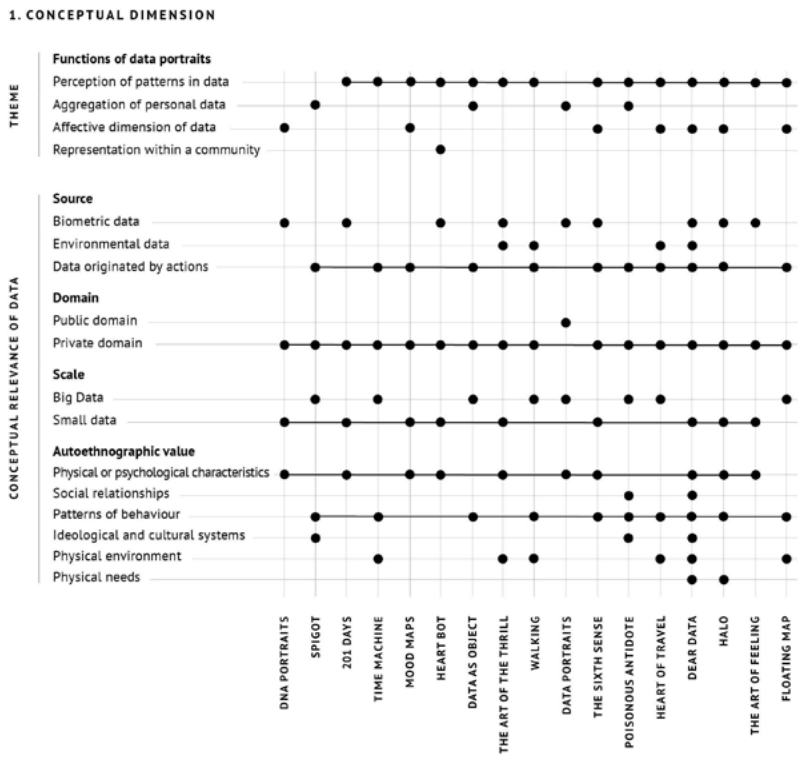

Fig. 1.
Comparative analysis of the conceptual dimension of the works.

The kind of data used pertains to *data originated* by actions, *biometric data*, and *environmental data*. However, while some projects privilege only one type of data, others correlate various types in order to address different aspects of the experience and identity of the subject portrayed.

All projects use data from the *private domain*, however, some extract it from the Big Data domain. So most of the projects reveal *patterns of behavior*, and some favor *biometric* data in order to infer psychological characteristics. Almost all data portraits (except 3) represent the individual through their habits and *activities*, as opposed to classic portraiture based on appearance.

Data and mapping processes

Almost all projects resort to passive methods of data collection, both in a *deliberate* or *non-deliberate* way, through sensors as well as self-tracking applications or even those which are not meant for self-tracking. In such a way, the latter seeks to tackle into questions about privacy through the appropriation of personal data. While in some projects the data *assembly process* is manual (data is inputted a priori, or gradually in chunks), only a few assemble data in real-time, having both data input and assembly processes automatically executed.

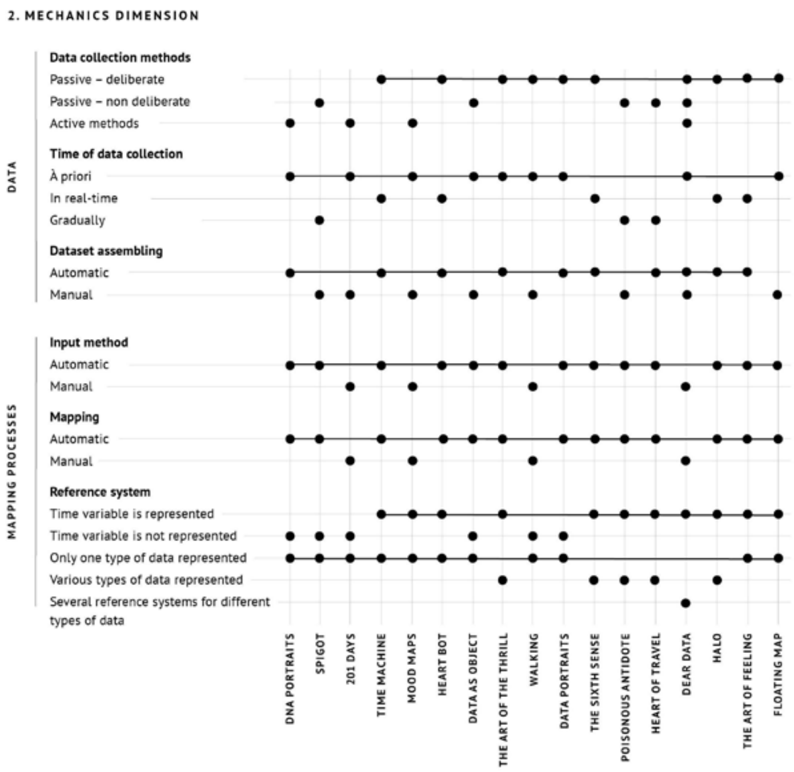

Fig. 2.
Comparative analysis of the works' mechanics.

The relevance of the temporal dimension is highlighted through mapping processes where the *time variable is represented*, mostly in order to express the variable nature of human experience. Only projects with a physical output involve manual mapping processes, being that all others resort to pre-programmed mappings that are automatically executed by a computational device.

Surface and dynamics

Although digitally produced, most data portraits have a *physical output,* be it *a static image* or a three-dimen*sional* object and, although less frequent, some present these physical outputs in installation or performance formats. Dynamic outputs are less frequent, as in *TimeMachine*, *Halo* and *HeART of Travel*, where the visualization can be interactively explored. Therefore, in terms of modes of expression, all projects privilege the visual modality (only twice complemented with sound), as well as a certain level of abstraction to the referent, although promoting the legibility of information through comparison.

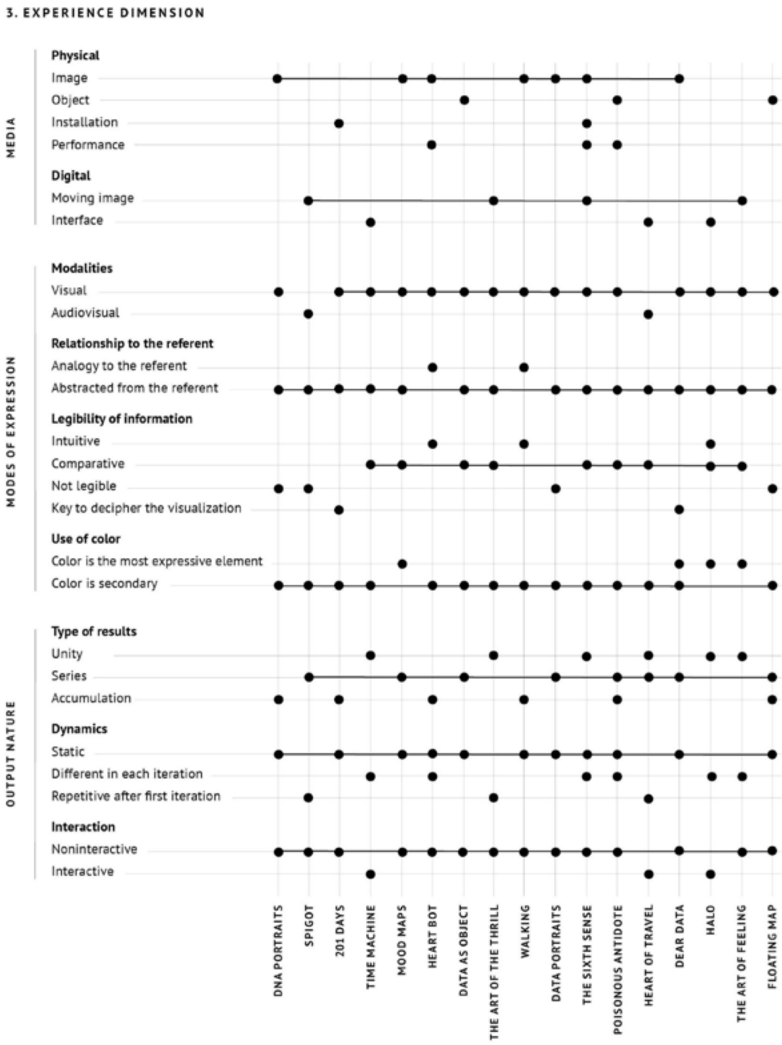

Fig. 3.
Comparative analysis of the experience dimension.

3.3 Interpretation

Regarding the conceptual dimension, we can observe how the choice of data relates to the portrait's intent. Most of the data portraits examined seek to reveal patterns of behavior arising from personal data, often associated to the subject's psychological traits. To this end, these portraits resort to data arising from the subject's actions or biometric data. Conversely, when the portrait's source data are related to the subject's surroundings, or environment, the aim is often to highlight how it influences each subject's behavior (this is especially relevant in projects such as *the Art of the Trill*).

The choice of data and mapping processes are closely linked to the project's aim, most notably when involving the aggregation of personal data, and the use of passive methods of data collection. The *perception of patterns emerging* from daily actions is emphasized, according to an autoethnographic approach that involves systematic data collection in an often passive and non-deliberate way.

Similarly, the features of the output are also closely tied to the data collection and assembly processes, whether manual or automated. As noted, the time variable is often represented in the reference system, regardless of whether data collection is done *a priori,* gradually or in real-time. So in order to express time, many of these data portraits consist of a *series or sequence* of visualizations that allows comparison between patterns emerging from the data or, in turn, resort to a sequential representation of time.

Another salient aspect is the expressiveness, and often abstract nature, of the visual outcome, thus distanced from an analytical stance concerned with legibility. Although part of the portraiture process, the analytical view is not reflected in the surface that often favors a subjective expression and the promotion of contemplation over exploration through interaction.

4 PROJECT: DATA SELF-PORTRAIT

Complementing the previous discussion and analysis of data portraits the project *Data Self-Portrait* creatively explores this notion through the development of a self-portrait generated from personal data resulting from everyday activities, following an autoethnographic approach. Therefore, it is important to consider which data "highlights the most salient features for evoking the individual" (Donath 2014, 215).

The project can be described according to three of the functions of data portraits previously addressed: a) observation of daily life through the emergence of patterns from the collected data; b) aggregation of personal data dispersed in software applications of daily use; c) exploration of the affective properties inherent to this data as indexes of personal experiences.

It was developed in two stages, the first being dedicated to the selection and collection of data and the later to the design and implementation of the visualization system that defines the visual outcomes giving expression and meaning to the data.

4.1 Data

We began by defining which data could have ethnographic value and what kinds of data would cover different areas of personal experience. Informed by the previous discussion, we selected data from three distinct domains: biometric, environmental, and data related to daily actions. Within each domain we were able to collect two types of data, namely: biometric data obtained from heart rate (in BpM) and energy spent (in kilojoules Kj) suggesting lived activities; environmental data regarding ambient noise (measured in dB) and temperature (in Celsius C°) as indicative of agitation or tranquility, potentially influencing the individual's mood; and finally, through geo-location, we measured distances traveled in relation to home as a reference point (in Km), as well as the number of web searches performed daily, as pertaining to specific activities regarding personal habits and interests.

It was important that the data collection process could be automatic in order to render the self-observation process more fluid, involving no direct intervention of the subject. Therefore, the data were recorded through sensors embedded in devices of daily use, such as our mobile phone, cardio bracelet, and self-tracking applications as well as records from web browsers.

4.2 Mapping process

Similarly, it was important to facilitate the mapping process by means of automatic execution, according to the idea of having an "intermediary mechanical artist" perform that mapping, so that the "representation of the subject's identity is controlled now by the program" (Dragulescu 2009).[10] To this end, we developed a program in order to generate the visualizations, comprising static image and a dynamic output that could be interactively explored.[11]

In this manner, the *Data Self-Portrait* is designed to represent everyday life from personal data by comparing the arithmetic average of the total values collected with the values of current measurements (displayed by the system at the time it is viewed). By comparing data of the present moment with the total average of collected data, the system highlights the variations in daily routine, revealing patterns that emerge from the subject's daily life.

10. As Dragulescu explains, "The actual data portrait is rendered by the intermediary mechanical artist, a program or a collection of programs that materialize the will of the artist/programmer. The mechanical artist blurs the lines between art material, art instrument, art experience and art object. (...). The software is one part material: the electronic canvas is the support on which the portrait manifests itself, and the interface is an integral, "tangible" component of the data portrait that allows for exploration; and one part instrument: it contains the code that collects and generates the final art object/experience" (Dragulescu, 2009).

11. The implementation of the visualization system implies the programming of an algorithmic process that systematizes the transcription of numerical data into a visual format. To operate this transition we chose the P5.js library for being browser-based (thus cross-platform) and open-source.

Visualization resorting to a polar coordinate system

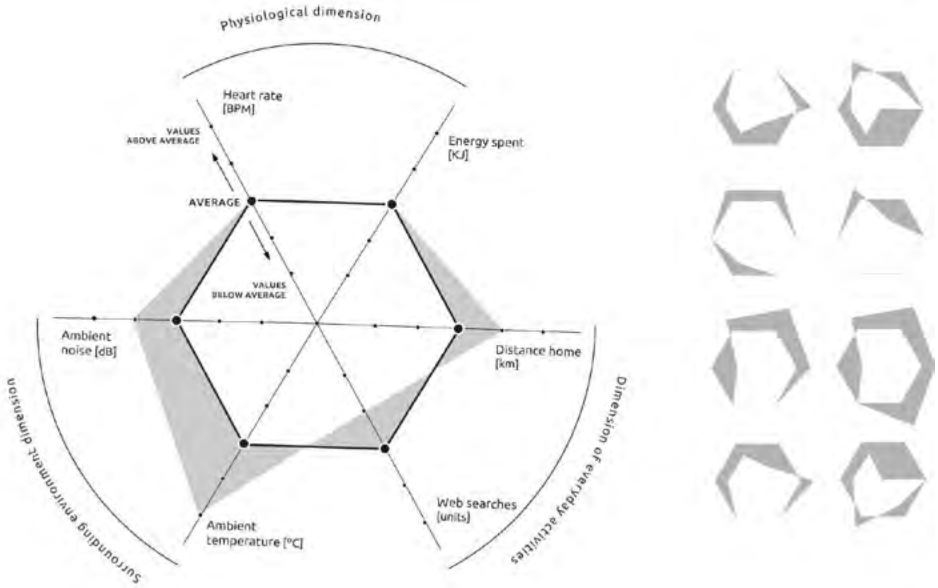

Fig. 4.
Mapping system based on polar coordinates

To visualize data we resorted to a radar chart where the daily average values are represented by the contour line of a regular polygon and where each type of data defines one of its vertices. The comparison between the average and the current time values that the system is reading is established by drawing a concentric irregular polygon whose vertices change according to the input data. So, below the average values are represented on the inside of the regular polygon and the data above the average values on the outside.

Visualization in a timeline

The output is essentially contemplative, in alignment with classic portraits. However, we found it appropriate to allow exploration of the portrait through interaction, since it condenses large amounts of information. The user can thus request information to the system and access data related to a specific period of time, through a timeline that serves as a navigation system.

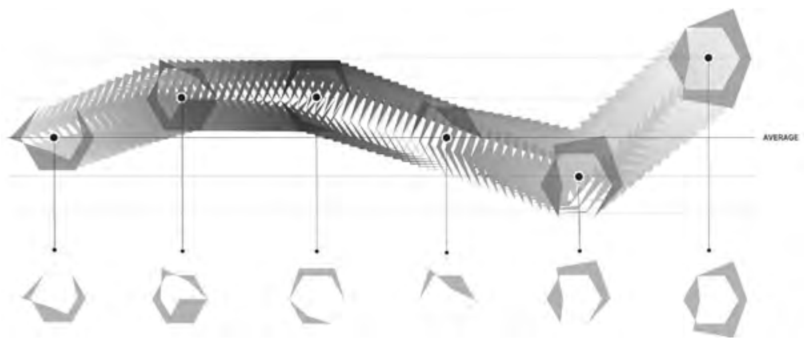

Fig. 5.
Mapping system based on a timeline.

Color plays an important role in this visualization because it expresses the comparison of each measurement to the average values, enabling us to see the variations to routine at a glance. The system checks the value of each of the six types of data collected, above or below average, and this variation is expressed on a scale of seven values (from 3 to minus 3).

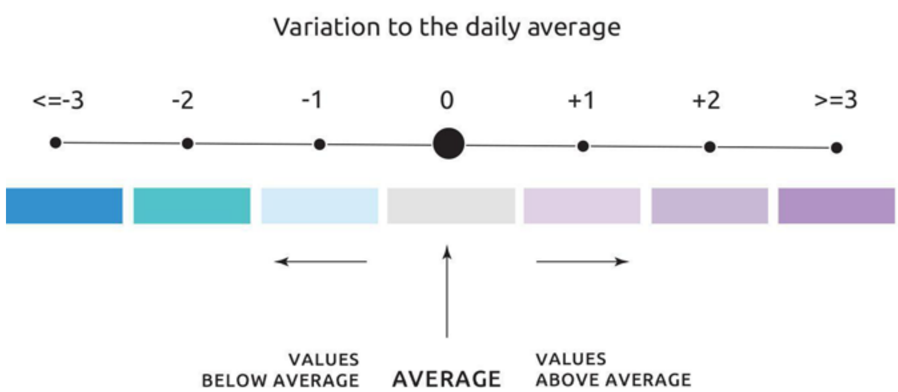

Fig. 6.
Color attribution.

4.3 Results

As shown above, the project explored different forms of visualization arising from the same dataset as complementary expressions of the data-self portrait. As part of an ongoing work, we are exploring these different results in the form of a physical object, a dynamic visualization, a printed publication[12] and a website that presents the project.[13]

The choice of a physical output seeks to evoke aspects of traditional portraiture, in the sense of a crystallization of a moment in time that is materialized for future contemplation. In turn, the dynamic visualization goes beyond this crystallization, revealing how human experience unfolds in time, as an evolving self-portrait. The aim of the printed publication is also to contextualize the development of the *Data Self-Portrait*, including the various visualization processes involved in its production, and the website serves the gradual aggregation of all elements of the project, having as its main content the dynamic visualization that can be interactively explored.

12. http://dataselfportrait.catarinasampaio.com/pub.pdf

13. http://dataselfportrait.catarinasampaio.com/

Fig. 7. Screenshots of the dynamic visualization.

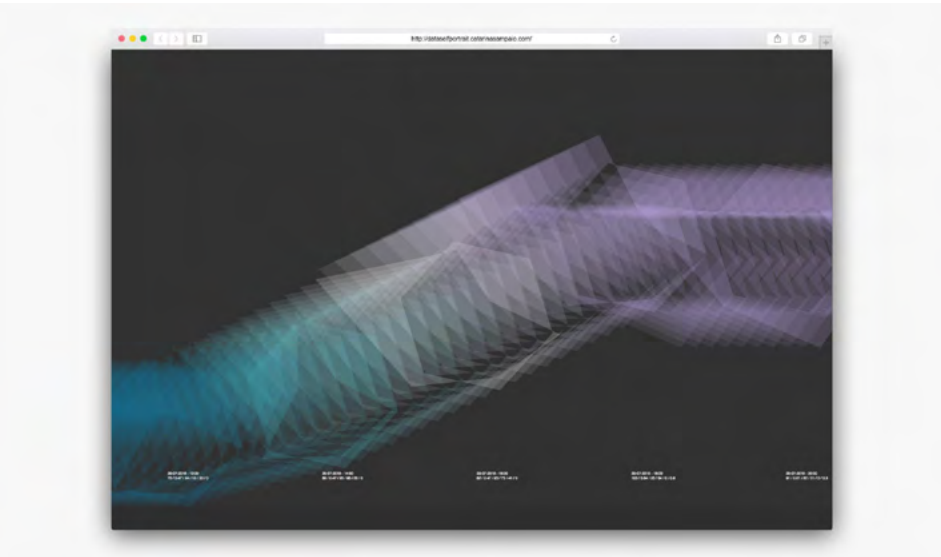

Fig. 8. Screenshot of the timeline.

5 CONCLUSION

This study addressed the concept of data portrait and the creative manifestations and possibilities inherent to this form of portraiture. This approach was motivated by the belief that this kind of representation and exploration of individual identity becomes increasingly relevant as a reflection of our contemporary mode of living immersed in data.

Following this idea, the project *Data Self-Portrait* was developed in order to explore the creation of primarily abstract visual representations of human identity generated from personal data, with the aim of exploring the creative possibilities inherent to data portraits and their different instantiations. Although the data portraits we analyzed and conceived tend towards abstraction, by being based on a quantitative approach and often algorithmically generated, they have the ability to evoke the individuality of a human being in ways that are not accessible to traditional portrait forms. In particular, by mapping human experience over time, these portraits express the fluid nature of identity, at a time when the continuous flows of information we generate and are exposed to, potentially change our perception of reality and of ourselves.

This approach also seeks to suggest how data portraits contribute to a reconceptualization of the portrait and of its inherent values, and how portraiture can become more attuned with our current selves, while taking into account our (currently inevitable) digital and online selves.

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Human-Algorithmic Curation: Curating *with* or *against* the Algorithm?

Keywords
human and algorithmic curation
curatorial biases
visibility gatekeeping
critical reflexivity

Although the cultural and social purpose of algorithms is the object of much public debate and contestation, their function is often compared with that of a renowned figure in the intellectual milieu: the curator. In this article I want to look at the relationship between these two agents – why they are compared and how they influence each other – in order to address the following question: is the curator working with or against the algorithm? Through the analysis of three hybrid artistic and curatorial experiments (including my own curatorial work) I want to problematise the false dichotomy of working either with or against the algorithm. I suggest instead that a critically reflexive approach to both the procedures of technology and art curating, to their biases and gatekeeping mechanisms, is necessary to address the crisis of cultural value brought about by the algorithmic world and for forging strategic alliances between humans and machines that can channel new forms of creativity and cooperation.

1 INTRODUCTION

In recent years, algorithms have become objects of scholarly attention, as a new wave of literature coming from the fields of critical algorithmic studies (Rutz 2016; Kitchin 2017; Bucher 2018) and experimental humanities (Finn 2017) is forging a cultural reading of them. This cultural reading is based upon the development of an *empirical* and *critical* (Kitchin 2017) understanding of algorithms,[1] which considers both the specific instructions they perform and how the latter are inscribed within a broader socio-economic system. This new current of literature argues against the dominant view previously held by computer scientists and technologists, according to which algorithms are "strictly rational concerns, marrying the certainties of mathematics with the objectivity of technology" (Seaver in Kitchin 2017) and attempts to create new interpretative roadmaps for understanding the increasing importance of algorithms in shaping social, cultural and economic life. Responding to this current wave of literature, in this article I situate algorithms in the gap between computational and material realities, information and meaning (Finn 2017), by acknowledging their socio-technical specificity and the power they exert on users everyday life and experience. According to this position algorithms can be described as "entangled, multiple, and eventful" entities which "are fundamentally productive of new ways of ordering the world" (Bucher 2018, p.20).

1. The notion of algorithm is ever expanding, as new algorithms are constantly being developed and implemented. Kitchin (2017) preliminary defines algorithms as "sets of defined steps structured to process instructions/data to produce an output." He then highlights the ways in which they operate by virtue of their contingent and performative nature and their embeddedness within wider socio-technical assemblages.

In parallel to these theoretical discussions, artists and cultural practitioners have begun to increasingly employ bots and software to expose, disrupt and challenge the hidden algorithmic infrastructures of online platforms and social media sites. While some artistic projects have explored the link between bots' performance, audience reception and market value, such as for instance Constant Dullaart, *High Retention, Slow Delivery Bots* (2014) and Erica Scourti, *Empathy Deck* (2016), other artists have taken an activist route into these issues. This is for example the case of the work by UBERMORGEN *Vote-Auction* (2000-2006), an online auction platform created during the 2000 US presidential election that claimed to allow Americans to sell their vote.

In the context of both these theoretical investigations and practical experiments, the role of the algorithm is often paralleled to that of the online curator. This is because algorithms are accountable for the organisation and arrangement of visual content on the Web through activities such as searching, collating, grouping, sorting, analysing, visualising. Within online platforms, they sort out content according to criteria of relevance for users as well as manage the interactions between them. While this view rightfully attributes curatorial capacity to algorithms, the danger is that it reduces the activity of curating to a purely computable task, discarding the fact that the latter also involves cognitive faculties, such as contextualising, interpreting, reflecting, sensing out, imagining, criticising and inserting humour. On the opposite side of this debate is the position held by those human curators who want to assert their superiority over machinic agents at all costs, maintaining that they do serve the public "in a way that big data and learning algorithms cannot" (Byrne 2015).

So the issue at stake is what kind of relationship the curator can create with the algorithm: In what ways can such relationship be described? As a relationship of antagonism, resistance or alliance? In other words, is the curator working *with* or *against* the algorithm?

Fig. 1.
Illustration from Steven Rosenbaum's article "Curate or Be Curated: The Coming Age of the Curation Economy", in www.huffpost.com.

In this article, I want to argue that both curators and algorithms are key "organizational nodes in cultural systems" (Nagler and del Pesco 2011) and acknowledge their growing interdependence in everyday socio-technical systems. As such I suggest the necessity to further explore the terrain of human and algorithmic curation, recognising in the latter the potential to overcome the "gap between computation and culture" (Finn 2017, p.55) by means of creativity and new forms of cooperation.

In what follows, I will analyse three examples of hybrid artists and curatorial projects, which have experimented with a mode of human and algorithmic curation: 1. *Cosmos Carl* (2014–), a platform "parasite" which fosters the creation of artistic interventions into social media sites and existing commercial platforms and hosts their links online (http://www.cosmoscarl.com); 2. The curatorial approach put forward by the Museum of Digital Art (MuDA) in Zurich, which involves the participation of the algorithm "HAL 101" in the process of curating (https://muda.co); 3. My own strategic alliance with the eBay algorithm "Cassini" within the context of the project *#exstrange* (http://exstrange.com). Through the analysis of such experiments I want to problematise the false dichotomy of working either with or against the algorithm, suggesting instead that a critically reflexive approach to technology is necessary to address the crisis of cultural value brought about by the algorithmic world and for envisioning new types of strategic alliances between humans and machines.

2 WORKING AGAINST THE ALGORITHM: *COSMOS CARL*, A PLATFORM PARASITE

Working with technology against its own grain has been a preoccupation of cultural practitioners and net artists since the early 1990s, when the space of the Web was still an uncharted territory characterised by "the endless joy of serendipity and strong feeling of responsibility" (Lialina in Andrew and Papadimitriou 2018). With the development of the commercial Web in the early 2000s, artists and curators began to shift their attention towards online platforms as sites for sociological and anthropological investigation on the one hand, and for emancipatory and political practices, on the other.

An interesting example of an hybrid artistic and curatorial experiment working with technology against its own grain is offered by *Cosmos Carl* (2014–), an initiative launched in 2014 by artists Frederique Pisuisse and Saemundur Thor Helgason. *Cosmos Carl* (2014–) consists in an online repository which hosts links to embedded projects occurring in external platforms such as Google Drive, Torrent, Pinterest, YouTube, Etsy, Instagram and eBay among others. By clicking on the links featured on *Cosmos Carl* website, visitors are re-directed to artists projects that are active or eventually "no longer available" on the Internet elsewhere. The interventionist character of the project is reflected in its underlining politics, which follows the legacy of 1960s cultural jamming practices and of early net art, respectively concerned with "the targeted application of the very method one intends to critique" (Elbaor 2018) and the resistance towards privately owned art. As Pisuisse and Thor Helgason observe:

> Cosmos Carl artworks are not necessarily political, but by utilizing platforms for the display of art, the contributions disrupt the platforms' usual traffic. In that way, the works potentially protest global platforms like Google and Facebook, even though they simultaneously accept their terms and conditions. (Pisuisse and Saemundur Thor Helgason 2017)

As the above statement reveals, the projects that *Cosmos Carl* (2014–) promotes play out a key tension: that between online users' automatic habit of accepting platforms' terms of service and the reflexive choice (often carried out by artists and creative practitioners) of breaching them to make their procedures more visible.

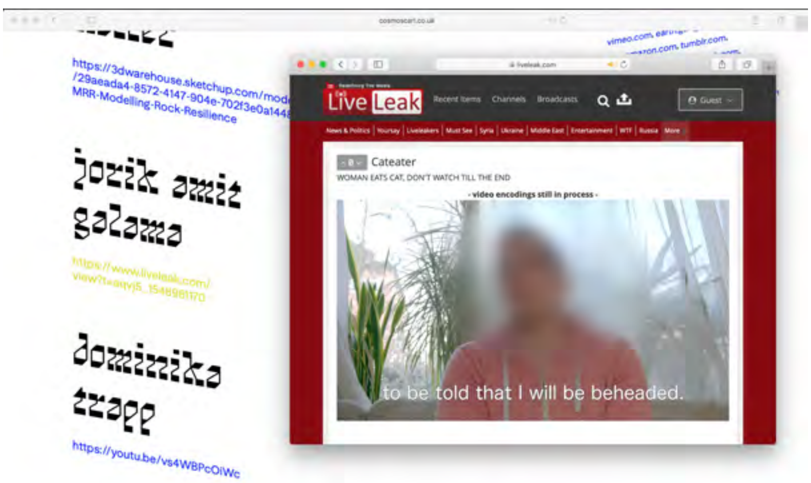

Fig. 2.
Cosmos Carl_Cateater_2019_Jorik Amit Galama

Moreover, because of the embedded nature of all the artistic and curatorial interventions it activates and hosts, the project operates in a grey area of practice between “not-just-art” (Fuller 1997) and “not-just-art-curating” (Tyzlik-Carver 2016; 2017). Two additional dimensions of interest are specific to *Cosmos Carl* (2014–). The first is that it brings to the fore the agential dimension of the technology underpinning each platform or social media site, as this forges the kinds of creative interventions that are possible under conditions of online embeddedness. For instance, an intervention on Pinterest poses a diverse set of challenges and opportunities than one on Tumblr or Instagram in terms of interface, image display and audience experience. In this respect, *Cosmos Carl* foregrounds a complex understanding of the platform not simply as a “networked repository or connective archive”, but crucially as an “apparatus that observes the world and generates ordering statements” (McKenzie 2018).

Fig. 3.
Cosmos Carl_Nude with Socks_2018_
Camilla Rhodes and Zoë Claire Miller

The second is its distributed and collective dimension, which is the ability to coordinate different interventions in several platforms. This aspect significantly increases the impact of the overall operation, which spreads like a “slow virus” (Pisuisse and Thor Helgason 2017), providing a connecting tissue for all the various interventions activated. What *Cosmos Carl* suggests is that the effects of such modes of practice cannot be judged in isolation or within a short timeframe, but can be valued in the long term and in concert with other similar operations. In other words, that their force lies in the ability to be part of and form a network of relations, that is to establish connection and exchange amongst creative practitioners on the basis of shared and differential values, intents and agendas. In the case of *Cosmos Carl* the aim is to produce a creative rupture in the system of “Platform Capitalism” (Srnicek 2016) – the present-day environment of Internet business models based upon the ownership of algorithms, hardware and digital infrastructures that foster the extraction and control of data and are centred around “the intensive techno-creative labour of users” (McQuire 2013).

However, the projects carried out within the context of *Cosmos Carl* (2014–) exemplify the increasing interdependence that online artworks and interventions have on the technical architecture and material substrate of commercial platforms, pointing to problems of *visibility, formalisation* and *documentation* that characterise the majority of interventions which are embedded online. These issues are a direct consequence of the process-based, computational and immaterial nature of the networked culture and the resulting transformation of the work of art into a networked image,[2] which exists and circulates beyond the physicality of the art object, yet is subjected to the volatility of digital content. They also highlight how algorithms perform a form of "visibility gatekeeping" (Magalhães and Yu 2017) or "censorship" (Finn 2017, p.111), impacting which data – images, information and material goods – are available and to whom.

2. The networked image is an image defined by its own conditions of online circulation which operates simultaneously as a mode of representation and computation. I discuss at length its status and its entanglements with processes of online curation in my forthcoming doctoral dissertation "Curating The Networked Image: Circulation, Commodification, Computation" (2019).

Cosmos Carl, by working against the algorithms and the apparatuses of specific commercial platforms, shows how the motives behind current modes of human and algorithmic curation can be of political and emancipatory nature, in the sense of being related to the urge of denouncing and critiquing the system of "Platform Capitalism" (Srnicek 2016). The following example, the one of the MuDA, adopts the strategy of working with the algorithm within the context of institutional practice and therefore pertains to a different kind of politics – one that concerns more closely the dynamics of the art world and its field of work.

3 WORKING WITH THE ALGORITHM: "HAL 101", THE WEB CRAWLER OF THE MUSEUM OF DIGITAL ART IN ZURICH

No other place than the contemporary museum can be more apt for observing the dynamics of art at work. The recently funded Museum of Digital Art (MuDA) in Zurich represents a case in point of a small and flexible institution that is currently experimenting with a mode of human and algorithmic curation.

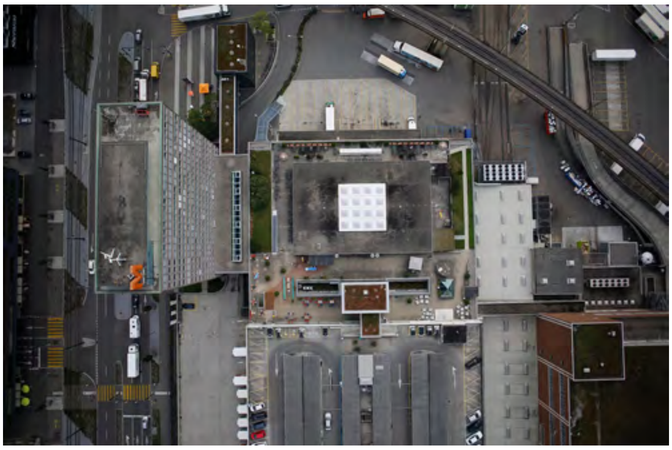

Fig. 4.
MuDA is the acronym for Museum of Digital Arts. It is also a Japanese word meaning futility, uselessness, idleness, superfluity, waste, wastefulness.
© Digital Arts Association

The team of the museum has decided to open the curatorial process to the participation of "HAL 101", a web crawler that searches the Web in order to index and select potential artists to exhibit.

In this way, the museum not only works with the algorithm, but also takes the whole notion a step further by means of actually programming "HAL 101". The fact that the MuDA is a non-profit cultural organisation whose mission is "untangling the digital fabric connecting data, algorithms and society" (MuDA website) frees this mode of human and algorithmic curation from the logic of profit, offering the opportunity to test the pursuit of a cultural agenda. However, the parameters that are used to encode the algorithm and the specific kinds of actions it executes under this allegedly transparent agenda remain rather opaque.

As can be learned from the museum's website, "HAL 101" has been instructed to look for artists whose data traces correspond with those initially chosen by the curatorial team for the museum's inaugural set of exhibitions (MuDA website). Therefore the working of the algorithm mirrors and executes decisions previously made by the curatorial team. The parameters upon which the algorithm has been programmed are not publicly disclosed and the information available is limited to the claim that the search that "HAL 101" performs insure that "nationality, age, gender or financial factors don't override the decision making process" (MuDA website). In the framing of "HAL 101" as a curatorial agent, the MuDA's team emphasises how the scope and reach of the algorithm prevents, or perhaps mitigates, the perpetration of art world biases, such as the selection of artists on the basis of their participation to a particular Biennale or their exhibition in an established gallery, offering instead visibility to artists who are not in the public eye. The fact that the algorithm creates a scoring system that is not personal and does not differentiate nor judge its information source is claimed as evidence of its democratic approach. Nonetheless, what this position disregards is that technology is never neutral or democratic (Chun 2009; Hendricks 2017; Bucher 2018) and that considerations of context and provenance of any information form part of a process of critical evaluation and analysis. In other words, it raises the problem that algorithmic associations, especially when devoid of context, generate their own set of incongruences and biases.

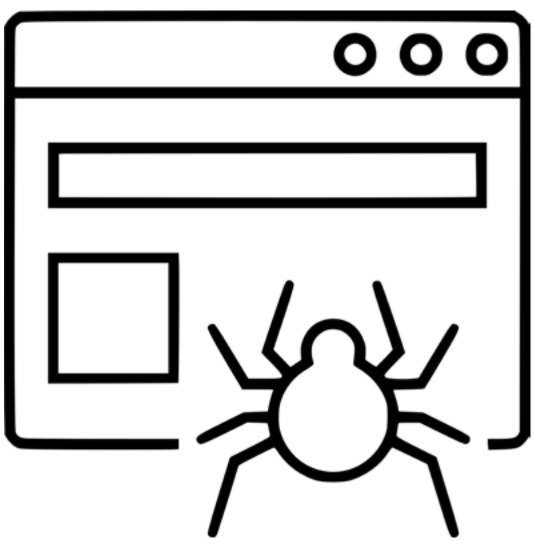

Fig. 5.
Web Crawler Free Icon.
Available from Online Web Fonts.

Indeed, in its attempt to overcome the curatorial biases associated to the activities of search, selection and evaluation, "HAL 101" inevitably amplifies the ones that are built-in on the Internet as well as creates new ones: its logic of objectivity and transparency is undermined by the fact that its choices are based on information which is already visible online. More explicitly, to information such as artists' names, titles and specifications of artworks which representation has already been given since they have been indexed by search engines. As such its attempt to critically reflect on the mechanisms of inclusion and exclusion the very process of curating articulates is not substantiated by an equally necessary awareness of the biases the algorithm itself generates and reproduces.

In its working as a curator, the algorithm is primarily used as a tool to simplify operations of searching and selecting, to reduce complexity in the decision making process and de-responsibilise the human curators from the difficult task of operating "cautious differentiation" (Goriunova 2012) from within the aesthetic complexity of the networked culture. By this, I mean to develop an attentiveness of the nuances between cultural appropriation and plagiarism, users creativity and savvy marketing strategies, web parody and defamation – all differentiations that rely upon the use of human cognitive faculties such as critical reflexivity[3] and knowledge. What the shortcoming of the model of the MuDA is pointing at, is the need for the curatorial function online to encompass not only a sophisticated knowledge of algorithms but also its very own critique, understood not as a dismissal of their potential, but as an opportunity to explore more thoroughly their wider socio-cultural impact. As Bucher lucidly puts it:

> Algorithms matter in a variety of ways: in their capacity to govern participation on platforms, distribute information flow, embed values in design, reflect existing societal biases and help reinforce them by means of automation and feedback loops, and in their power to make people feel and act in specific ways. (Bucher 2018, p.120)

Consequently, she further observes, "knowing algorithms might involve other kinds of registers than code" (Bucher 2018, p.113), such as the register of critical analysis, speculative inquiry and poetic imagination.

3. "Critical reflexivity" is here understood as a quality belonging to humans only. My use of the term draws upon Alvesson and Köldberg's framing of reflexivity as "ways of seeing which act back on and reflect existing ways of seeing" (Clegg & Hardy, 1996, p.4 cited in Alvesson & Köldberg, 2009, p.271), whereby the act of seeing is "inseparable from the perspective, it is perspectival" (Alvesson & Köldberg 2009, p.6). It is coupled with Scott Lash's understanding of critical reflexivity as a mode of reflexivity whose reference shifts 'from everyday experience to "system", of commodities, bureaucracy, or reification of life forms' (Lash 1994, p.140).

4 FORGING A STRATEGIC ALLIANCE: "*CURATORIAL CONSULTANCY SERVICE WITH CASSINI*" ON *#EXSTRANGE*

My strategic alliance with the eBay algorithm Cassini attempted to play with these other registers – critical, conceptual, poetic – and as such sits at the crossover of these different examples. It was developed within the context of the project *#exstrange*, an initiative mobilised by curators Marialaura Ghidini and Rebekah Modrak that used the online marketplace of eBay as "a site of artistic production and cultural exchange and as an artistic intervention into capitalism" (Ghidini and Modrak 2017).[4] The premise

4. For an in-depth description and analysis of my contribution to the project's *#exstrange*, see my essay for its catalogue (2017) and my forthcoming doctoral dissertation (2019).

of the project was to treat the idea of the auction as an artwork: hence the category chosen, the images uploaded, the prize and the description. Everything was to be considered part of the artwork and each auction would run for seven days. All auctions and interactions with buyers were documented on the project's website (http://exstrange.com) and in a catalogue published in the summer 2017. Through this conceptual framework, the curators were aiming to place art in a context where it could solicit an "exchange with a stranger",[5] from where the title *#exstrange* developed.

5. Here "stranger" recalls the sociologist and philosopher Georg Simmel's use of this term, understood as a figure characterised by nearness and remoteness, who enters into a community able to perceive entrenched dynamics with new eyes (Ghidini and Modrak 2017).

When reflecting upon the actual visibility of the project *#exstrange* and its penetration within the platform, it became clear that the latter was executing a key operation of mediation between the project and its publics by means of its search engine and "best match system". Further to exploring eBay analytics I soon discovered that the eBay search algorithm was enhanced in 2013 to improve the platform's overall performance, selling standards and costumer satisfaction. Interestingly, eBay renamed its algorithm after a NASA space probe dedicated to a famous Italian-born astronomer of the Seventeenth Century, Giovanni Domenico Cassini.[6]

6. Cassini was the first to take successful measurements of the solar system latitude and to discover what became known as the Cassini Division in the rings of Saturn. The Cassini Mission to Saturn, which started in the early 1980s and terminated on September 15th 2017, was one of NASA's most renewed missions in recent times.

Fig. 6.
Photograph of Giovanni Domenico Cassini. Collection of Yesterdays Photos, 2017. In eBay.com "Art > Art from Dealers & Resellers > Photographs." Screenshot of eBay.com website.

Cassini replaced eBay's previous search engine, Voyager, revealing the consistent fascination of eBay developers with the imaginary of the NASA. Its implementation, led by the then eBay's vice president of experience and search Hugh Williams, was part of a rebranding strategy which began around 2008 and that marked a new era in the platform's history: the move from a seller-oriented marketplace to a customer-centred one.

The parameters and visual language of my strategic alliance with Cassini were defined through the process of interacting with the platform's interface and database, from the choice of the listing's category to its full descriptive text and the images uploaded. The little known eBay sub-category chosen for my auction "Specialty Services > eBay Auction Services > Appraisal & Authentication" assisted the purpose of highlighting that the sale consisted in an unusual service and that such service was closely related to the mechanisms of validation of the platform itself. The "item specifics" described a mode of human and algorithmic curation, which aimed at merging a quality usually associated to humans (reliability) with one generally attributed to machines (efficiency), through the common channel of creativity. The latter was framed and put forward as a property that cannot be located in either humans or machines alone, but "it is found in their interrelationships, in-between" (Goriunova 2007).

Although available to all eBay users, the service was specifically addressed to artists or curators interested in exploring the currency of their name and their listing in the liminal space between the commercial platform – the so-called "eBay universe of happy transactions" (Hsiao 2017) – and the art world. The curatorial consultancy service placed particular emphasis on two key success markers – visibility and criticality – which weigh the relevance of an artist or a work of art in both the art market and the institutional establishment. These success markers are usually hard to quantify and control since they depend upon highly subjective and volatile criteria, such as fame, chance, taste and market fluctuations.

By invoking the calculating capacity of the Cassini algorithm in the process of evaluating them, through the strategic alliance I performed a double mandate: on the one hand, I aimed at exposing the arbitrary mechanisms of the art world and its market – mechanisms of judgement, validation, inclusion and exclusion – and traded them as assets in a commercial exchange; on the other hand, I wished to confront "a certain tyranny to the curator's role" (Brand 2011), by testing a more open and transparent approach through the involvement of a non-human agent. Overall, I attempted to perform an institutional critique of the system of art curating by recognising the influential role the curator plays in shaping not only "the public tastes but the very value system of art" (Tyżlik-Carver 2016, p.51). The affordable price of the consultancy service – only $15 – reiterated the urgency to challenge mechanisms of curatorial gatekeeping and to redistribute agency more evenly across all agents – artists, curators, algorithms and online users – involved in the process of curating.

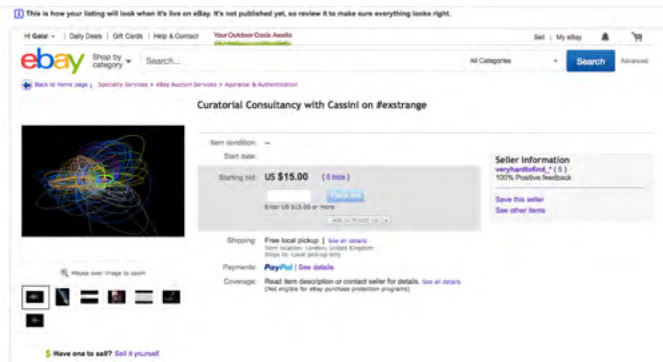

Fig. 7.
Gaia Tedone, *Curatorial Consultancy Service with Cassini on #exstrange*, 2017. In eBay.com "Specialty Services > eBay Auction Services > Appraisal & Authentication." Screenshot of eBay.com website.

A number of actual benefits were offered as part of the consultancy, including: unlimited Skype and telephone assistance towards the creation of a listing that the algorithm Cassini would rank well; the co-creation with Cassini of an eBay collection tailored on the buyer's listing and personal tastes; the fabrication of an electronic report summarising the key findings emerging from this experimental mode of human and algorithmic curation; a special announcement during a public event in a prestigious London Gallery which aimed at extending the buyer's visibility from the platform to the art world.

The visuals accompanying the listing drew together the language of astronomy, search optimisation and online curation. They included satellite generated images produced by the Cassini space probe, a lithograph of the astronomer Giovanni Domenico Cassini and two screenshots taken from the platform featuring the error messages that appear when a given listing cannot be seen or accessed in a specific location or at a given time: "this listing has been removed, or this item is not available' and 'this item isn't available in your location". The function of the latters was to hint at the possibility that a mode of human-algorithmic curation could help circumnavigating visibility problems on the platform and fashioning new modes of visibility.

The listing went live on March 23rd at 10 UK time. It was artist Alessandro Sambini, registered on eBay as user "Afaja", who purchased it. As part of the consultancy, I conferred with Sambini and guided him through the production of a brand-new listing entitled "*Portable Wildlife Image Instance*". Sambini's auction ranked at the top of the eBay search. This was due to its original title, witty description and high quality photographs — three features that the previous study of Cassini had revealed as key. After fierce competition and thirty-two different bids, user "Temporama" bought "*Portable Wildlife Image Instance*"[7] at the price of $44.00, for an increased market value of 40.5%.

7. Sambini's listing played with the tropes of contemporary landscape photography and Dada ready-made and sold half of a shopping bag of the multinational retailer Tesco depicting the image of a generic countryside view.

The kind of operation the strategic alliance with Cassini produced can be first and foremost described as *conceptual*, in the sense of working with different planes of imagination, and *critical*, in the sense of soliciting a reflection about the algorithm's concealed role within the platform. The polysemy of the word Cassini on the Web was instrumental for these purposes, since it enabled to put in relation different concepts (Cassini the Astronomer, Cassini the space probe and Cassini the Algorithm), fields (science, culture, technology) practices (art curating, business, hacking) and regimes of visibility (the human language of signs and symbols and the computational code of numbers and data). To provide a foundation to the strategic alliance with the algorithm, a new aesthetic and semantic coherence was created out of the remix of these different planes of information and imaginaries. Such remix was enabled by the simple operations of cut-and-paste, which are available to online users and that allow the de-contextualisation and re-contextualisation of content (Paul 2006; Groys 2016). In this case, human and algorithmic curation operated as a method to forge a conceptual and cultural reading of the algorithm and to re-envision technical practice as a crucial aspect of culture from which poetic performance can originate.

However, through the course of the experiment, the premises of my strategic alliance with Cassini, which were based upon the complementarity of aims and actions between the algorithm and myself, were complicated. This is because I discovered that the curatorial capacity of the algorithm was inextricably linked to the wider dynamics of control over users' data and behaviours that eBay implements because it is a commercial platform. In other words, the Cassini algorithm was acting as a visibility gatekeeper, determining what users see, know and consume on the platform. Additionally, it also created an "art filter bubble" – an algorithmically-delineated community of artists and art professionals whose online preferences and searches qualify them as already part of a particular system. Consequently, the circulation of my project and its sale remained confined within the perimeter defined by the project *#exstrange*, even if its premise was to open up such confines by challenging the conventional paradigm of art curating through a mode of human and algorithmic curation.

This outcome points to an important paradox which describes the state of artistic and curatorial interventions online: either they exist within predefined contours that link them back to specific systems of reference and fields – these being for instance the contemporary art and new media worlds or the academia – perpetuating old institutional separations that the logic of the Web attempts to disrupt – or they risk dissolving within the plethora of content produced online or disappearing entirely from the Web.[8]

8. To overcome this problem and clearly define project *#exstrange* as an experimental media project, Ghidini and Modrak created a dedicated website, autonomously managed and "all rights reserved". The latter served the key purpose of documenting and archiving the project, in other words to prevent its own disappearance from the platform and the Web.

This was, for instance, the case of an earlier experimentation with the eBay algorithm performed by artist Angie Waller, entitled *EBay Longing* (2003), which left little trace online. Waller's intervention, which was realised ten years before the Cassini algorithm was introduced, consisted of scraping the eBay database during the years of the so-called "war on terrorism" using the word "Afghanistan" as the search query. The aim of this quasi-anthropological study was to explore the shift in the sale of objects in countries such as Syria, Afghanistan and Iraq through the collection of a few hundred images. The images depicted objects spanning from memorabilia and souvenirs to American-made T-shirts bearing slogans in support of the war, alongside bumper stickers and miscellaneous items that the troops were sending back home. Waller's intention with this project was to critically reflect upon the relationship between users' activity and the performance of the algorithm as influenced by specific cultural trends and contingent political biases.

Unlike my experiment with Cassini, which operated with the algorithm to produce a moment of dissonance, ambiguity and critical reflection, Waller's project more overtly pursued a hacking strategy, consisting in the actual manipulation of the data generated on the platform. But in spite of this difference, both projects pointed to the problem of human and algorithmic curation and its entanglement with broader questions of power and control associated with the use and implementation of technology. This is a topic that Waller has continued to explore in her subsequent works, such as for instance *Data Mining with Amazon* (2003) and *How to Look at Artist Networks* (2015) – works concerned with the algorithms of Amazon Database and Google Knowledge Graph. The latter project, in particular, offers an interesting counter-point to the MuDA's example, since it illuminates how the Google algorithm "Knowledge Graph" potentially collapses art historical canons and produces incongruent associations devoid of context.[9]

9. For more information on Waller's project, see: https://angiewaller.com/how-to-look-at-artist-networks-2015/.

5 CONCLUSIONS

The comparative analysis of these examples suggests that a nuanced approach should be developed in regard to the kind of relationship the online curator shall create with the algorithm and that the false dichotomy of being either *for* or *against* the algorithm must be surpassed. It also revealed that curators and algorithms similarly take up the role of cultural and visibility gatekeepers since they both operate through mechanisms of filtering and selection; such gatekeeping mechanisms, if not attentively recognised and monitored, could even be amplified through their co-operation. For this reason the development of strategic alliances between curators and algorithms must be based upon the critical awareness of both their complementary roles and potentially similar biases. More precisely, these strategic alliances would need to incorporate a critical reading of both the algorithm and the curatorial process involved, their potential biases and filtering mechanisms; the parameters of such alliances would need to be negotiated case by case; their outcomes would depend on the kinds of values that are encoded in the algorithmic system and which the alliances aim to produce and co-create. Under this light, experiments in the field of human and algorithmic curation can offer the opportunity to implement a mode of "processual criticism that is both reflexive and playful" (Finn 2017, p.13), whilst also bringing to the public attention urgent debates concerning the wider implications algorithms have on society and the increasing interdependence between humans and machines in everyday life. Their social and cultural remit could be to develop a fine-grained reading, interpretation and informed questioning of the socio-technical transformations brought about by the algorithmic world and to firmly position human agency at the core of such transformations.

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The variables of spatial presence: a parametric model

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The term 'spatial presence' refers to the feeling of presence in a mediated space. This subjective experience has been discussed in media theory, sound art, film and performance. It depends on multiple variables, or parameters. This paper presents a parametric model that can be used to analyze those variables and their relationships. It exposes methods to assess interaction, characteristics of sound and image, audio-visual relationship and physical setup. It also exposes methods to assess how these variables intertwine in perceptual experience. The model draws from perception science, interaction design, music and audio-visual theory. It is applicable to the broad diversity of aesthetical options and technical platforms, facilitating the analysis of spatial presence in any performance. One can also discard part of the parameters so as to analyze installations, sound art and film.

1 INTRODUCTION: WHERE IS 'PRESENCE'?

In media theory, Draper et al. proposed that spatial presence depends on attentional processes [1998]. Schubert described it as "a feedback of unconscious processes of spatial perception that try to locate the human body in relation to its environment" [2009:15]. And Sacau et al. stressed that it is informed by the properties of media stimuli as well as by individual psychological factors, such as the capability to be immersed [2008]. These authors concluded that in radio and TV the sense of spatial presence depends more on the active suspension of disbelief than on the properties of media stimuli. Conversely, in complex interactive virtual environments designed to convey participatory interaction, the sense of spatial presence would depend more on the properties of stimuli. These conclusions might be arguable, but their starting point is solid: spatial presence depends on stimuli as well as individual predisposition. Moreover, stimuli can condition predisposition and attention to a lesser or greater degree.

Music and sound art can make us feel present in a space that is suggested through recognizable sounds; as an example, the sound of the ocean can convey the sensation of a maritime environment. However, we can equally speak of presence when sounds are not recognizable. The composer Francisco López wrote about a particular sense of spatial presence in music: "Being 'inside' the sound (instead of listening to it) creates a strong feeling of immersion where your own body moves into the perceptive background" [2004]. In sound art philosophy, Salomé Voeglin stated that audition differs from vision because "seeing happens (...) away from the seen"; according to her, this distance enables a detachment and objectivity that presents itself as truth [2010:12].

The term "detachment" must be put into perspective, because narrative film and media can forge audio-visual relationships so as to convey presence in a suggested space beyond the screen. In the physical world, we use multiple cues for detecting the material environment, including the position of objects and events. Film and media can create a convincing sense of space with much fewer cues, because each event activates unconscious memories of similar real-world events. Michel Chion coined the term *superfield* to designate the sound space created by multi-track sound and multi-speaker placement in the movie theatre [1994]. The superfield does not depend on what we see moment by moment on screen; instead it provides "a continuous and constant consciousness of all the space surrounding the dramatic action" [1994:150]. The superfield also exists with digital 3D environments, whether the output sound is emitted through a stereo system or a multichannel system. The term '3D positional audio effects' applies to software that makes sound spatialization depend on visual dynamics. This audio-visual correspondence mimics how we perceive the physical world, conveying a sense of 'immersion' in the digital world.

In electronic music performance, the mediated space of presence can be centered on the performer, or expand to the environment. Simon Emerson's distinction between local functions and field functions is useful to illustrate this idea [2007:92]. Whilst local functions seek to extend, but not break, the perceived relation of human performer to sounding result, field functions create a context, a landscape or an environment where local activity may be found. Emmerson prefers not to play down this division, but add supplementary dimensions to it - local can become field, and vice-versa. He uses the term *performative arena* to describe the relation between performer, audience, space, sound sources and events.

Other researches reflect similar ideas. Birnbaum et al. consider “the total physical area inhabited by the instrument/ system” as a variable in performance [2005]. And Ciciliani distinguishes between *centripetal* and *centrifugal* performances [2015]. In centripetal performances, the performer is visible and the centre of attention. The relation between his physical action and the sonic results is clearly perceivable, and the sound sources are placed near to him. In centrifugal performances, the performer is in a hidden position. He functions as a controlling rather than enacting entity; there is little or no correspondence between his physical actions and the sonic results, and the sound sources are spread in space.

The notion of performative arena is very useful to our investigation: we can say that it relates the physical and psychological space of the work. It corresponds to how the work creates the potential space of presence. That might depend on the characteristics of the sound, the image and the audio-visual relationship, on the performer’s interaction with the system, the speakers’ placement, the spatial relation between performer and visual projection, if any, the lighting, the physical architecture, and the audience location. The feeling of presence is also informed by individual predisposition, but that does not depend on the work, and we will not attempt to parameterize experience itself. Instead, we will glean a set of verifiable variables, and provide methods to interpret their relationships.

We examined several of those variables in previous publications, which introduced methods for analyzing sonic expression and sensory dominance [Sá 2013; Sá, Caramiaux and Tanaka 2014; Sá 2017]. Those previous investigations are a stepping stone to the work presented in this paper. Section 2 will illustrate a set of low-level variables, or parameters, with artistic examples from the sonic, the visual and the audio-visual domain. Section 3 will introduce two high-level parameters, so as to characterize semantics and the performative arena. It will examine how the high-level parameters are informed by low-level parameters, and provide artistic examples as well.

2 LOW-LEVEL PARAMETERS

This section parameterizes interaction, sonic and visual dynamics, audio-visual fit, and performer’s position relatively to image. Each parameter is gleaned and exemplified independently from the others.

2.1 Interaction

Birnbaum et al. [2005] and Magnusson [2010] created parametric models to analyze interaction with digital music devices. Both models include parameters related to the performer's control over the device and the foreknowledge required in interaction. We can summarize those variables into a single parameter: the performer's cognitive effort, including all kinds of information processing, conscious and unconscious.

In a previous publication we elaborated on how different levels of effort convey different notions of musical expression (Sá 2017). This is equally applicable to the sonic, the visual and the audio-visual domain. As a parameter, effort can be quantified as follows:

- **Little effort** means one of two things: either the work does not depend much on real-time interaction, or the relationship between deliberate human agency and output results is linear and clearly perceivable.
- **Medium effort** means that interface behaviors are complex, with a certain potential for unpredictability; the performer needs particular skills to play the instrument, but a sense of immediacy conveys fluency and timing, and/or technical configurations rule out undesired outcomes.
- **High effort** implies particular skills and/or high cognitive demand; the interaction with the system does not feel immediate, and/ or the system does not rule out any outcomes.

An example of little interaction effort can be found in Phill Niblock's *Movements of People Working*, performed since 1973.[1] These works show repetitive movements of manual labor combined with massive drones of sound, rich in harmonics and overtones. There is no technological connection between sound and image, and yet, the connection between what we hear and see is undeniable. Niblock's real-time interaction with the laptop consists of choosing media files and pressing the playback button from time to time. The visual component is created in advance, and at least part of the music is pre-recorded as well (other musicians might play live, following his minimalistic scores).

Another example of little effort can be found in *Music for Solo Performer* by Alvin Lucier (1965)[2], where he uses a brain interface to activate multiple percussion instruments. The strength of the brain wave signal is inverse to the actuation upon the instruments - the sound is loudest when he is in a kind of meditative state. This work raises an interesting issue: the interaction with an effortful interface can be effortless. Indeed, brain waves are hard to control. But in an interview Lucier explained that he didn't want to show mind control, because he preferred the discovery of how his brainwaves sounded.[3] To him, composition was about how to deploy the loudspeakers and what instruments to use.

Medium effort can manifest in that which Jeff Pressing called dynamic complexity [1987]: a rich range of behaviors over time, an adaptation to unpredictable conditions, a monitoring of results in relation to a reference source, and an anticipation of changes in oneself or the environment. We can say that medium effort implies behavioral deviations, and reactions to those deviations.

A musical example is in a performance by Joel Ryan (electronics) and Evan Parker (soprano saxophone), 2012.[4] The sounds of the saxophone and the electronics intertwine like a braid, with floating tonal centers.

1. https://www.youtube.com/watch?v=mCKtqsy9gcY; https://www.youtube.com/watch?v=LJtIZskdHOc

2. http://daily.redbullmusicacademy.com/2017/05/alvin-lucier-music-for-solo-performer

3. 1986 interview with Ev Grimes for Yale's Oral History of American Music

4. https://www.youtube.com/watch?v=IQ4DqRgtbHc

They converge when their loudness and tone are the same, then they cause attention to focus on subtle tonal shifts, diverging progressively as one timbre emerges from the other, so as to converge again.

Another example of medium effort is in an audio-visual performance by Steina Vasulka at the Smithsonian American Art Museum[5] (2012). The work pertains to her *Violin Power* series, in which she controls video footage with an electric violin with MIDI output[6] (the Zeta Violin). We can speak of audio-visual tension whenever she transits between different segments of video footage; these transitions are abrupt at the visual level, but not at the sonic level. The subsequent return to audio-visual synchrony creates a convergence, which causes a sensation of release.

5. https://www.youtube.com/watch?v=9mg1weOHWSs

A high level of effort conveys yet another type of expression. A paradigmatic example can be found in the work of Martin Howse, which deals with *psychogeophysics* since 2009.[7] Howse investigates the links between geophysical phenomena, software and the human psyche, proposing a return to animism within a critical misuse of scientific technology. In performance, his interfaces combine a diversity of chemical substances, earth materials and computers. Similarly to Lucier, Howse emphasizes discovery, as opposed to control. But very differently, the output is highly dependent on his real-time decisions and actions.

7. https://vimeo.com/54006161

2.2 Dynamics

Another relevant question in the analysis of spatial presence is how the dynamics of sound and image drive attention. Drawing from neuroscience and psychology, we created a taxonomy of continuities and discontinuities related with intensity and attention (Sá 2013). It was useful to define intensity as the 'neural impact of any change in the chain of stimuli causing an increase in neural activity'. Since neural activity reflects attention, we can quantify intensity based on how attention works.

Attention is automatic when driven by salient events, such as the sudden appearance or disappearance of a stimulus. Such events counteract biophysical expectations, causing a great increase in neural activity. Conversely, attention is under individual control when expectations are fulfilled, requiring little neural activity. It is important to note that expectations depend greatly on the panorama - previous and simultaneous events, and the duration of experience. Also, the threshold between deliberate and automatic attention can be fuzzy. That is because attention causes us to optimize perceptual resolution, so as to better process information related to the attention target [Knudsen 2007]. Deliberate attention can make the intensity of any detail changes grow exponentially. As those inform expectations, we also become more susceptible to automatic attention.

In summary, intensity is proportional to perceived discontinuity. It depends on the event itself, on the panorama, and a person's perceptual resolution. We created the following taxonomy of continuities and discontinuities related with intensity and attention:

- **Steady continuity** has no intrinsic motion; it is of lowest intensity, dispensing with attention. Attention is likely to deviate and focus upon any simultaneous stimuli, or upon internal states.
- **Progressive continuity** occurs when successive, non-abrupt events display a similar interval of motion. It fulfils the expectation that once something begins to move in a certain direction, it will continue to move in that direction (Gestalt of *good continuation*).
- **Ambivalent discontinuity** refers to the threshold between continity and discontinuity. At low perceptual resolution – when a person is not paying attention - the foreseeable logic is shifted without disruption. At high resolution, discontinuities become more intense – even disruptive. Higher intensity implies greater attention/ neural activity, and lower intensity implies lesser attention/ neural activity.
- **Radical discontinuity** violates psychophysical expectations, prompting automatic attention. It is of highest intensity, given the great demand of cognitive processing. Radical discontinuities are always prioritized in the stimuli competition to reach conscious awareness.
- **Endogenous continuity** corresponds to the mental representation of perceptual motion; it can combine all the other types of continuities and discontinuities. We use the term endogenous so as to stress that perceiving a coherent relationship between them depends greatly on the individual.

We can say that every artistic work aims the audience to experience endogenous continuity, but all the other types of continuities and discontinuities can be illustrated with paradigmatic examples.

A musical example of steady continuity is Elaine Radigue's *Triologie de la Mort* (1998),[8] a three-hour drone piece, where we hardly perceive any overtones/ harmonic variation. The work follows the path of the continuum of the six states of consciousness according to Tibetan Buddhism. An audio-visual example of steady continuity is La Monte Young and Marian Zazeela's *Dream House*,[9] an ongoing installation (since 1962). The work defines a vibratory space through the combination of continuous sound frequencies and continuous light frequencies, experimenting on how people are drawn to inhabited it.

The notion of progressive continuity can be illustrated with any gradual increase or decrease in loudness, tonality, brightness, color, density, rhythm or time length. A concrete example can be found in Gary Hill's film *Black and White Text* (1980),[10] which explores a relationship between geometric black and white figures and human voice. As the work unfolds, the intervals between the words and the visual changes become progressively shorter, while sound layers accumulate and rectangles multiply on screen. Importantly, we cannot speak of progressive continuity unless we perceive motion. If the progression happens so slowly that we cannot apprehend any change (as happens in Radigue's *Triologie*), we should rather speak of steady continuity.

Whereas progressive continuity entails motion in a clearly perceivable direction, ambivalent discontinuity entails multi-directional motion.

8. CD released by Experimental Intermedia Label

9. https://www.youtube.com/watch?v=3ahgq-zVQLc

10. https://www.youtube.com/watch?v=bg1O3NcPwBg

11. https://www.youtube.com/watch?v=ojVX8FWYc4g

12. https://expcinema.org/site/en/dvd/phil-niblock-movement-people-working

13. http://www.fondation-langlois.org/html/e/page.php?NumPage=481

14. CD released by Blast First Petite, https://www.youtube.com/watch?v=kPhkH1da08o

15. https://vimeo.com/49873167

A paradigmatic example is in Thomas Wilfred's *Lumia* (1930s).[11] The Lumia were dynamic light-paintings performed with the *Clavilux*, a visual instrument that made use of multiple projectors, reflectors and colored slides. These works consist of polymorphous, fluid streams of color, which invite attention to focus on subtle detail changes. As another example, Niblock's Movements of *People Working*[12] invites perception to focus on the nuances of sound and image - the repetitive movements of manual labor and the continuous mass of sound. As we increase perceptual resolution, the detail variations become more intense.

The fuzzy threshold between ambivalent discontinuity and radical discontinuity can be exemplified with *Stellar* (1993), one of Stan Brakhage's silent abstract films. Inspired by Norman McLaren, he drew directly on film. The film has elements of continuity; all frames are made with same technique and the same colors. And yet, as we focus on the visual detail changes proliferating in the fast-changing frames, we also become very sensitive to how the interplay of discontinuities grounds the construction of time.

Radical discontinuities can be used so as to create rhythmic patterns, as happens in Vasulka's *Heraldic View* (1974),[13] or in club music. When the duration of the experience is short, each abrupt event prompts automatic attention, causing a sudden increase in neural activity. Yet after a while, the sequence of elements fulfils expectations, as happens with any pattern; in this way, radical discontinuity turns into steady continuity. Alternatively, radical discontinuities can be explored so as to tease and counterpoint expectations. For example, the *Corona* CD by Pan Sonic (2010)[14] uses radical discontinuities, but sparsely. In the audio-visual domain, Ryoji Ikeda's performance *Superimposition* (2012)[15] creates radical discontinuities with sudden blackouts; the contrast with moments of progressive and steady continuity makes those discontinuities more intense.

2.3 Audio-visual fit

The way perception prioritizes sensory information is influenced by the dynamics of sound and image, but the surplus of meaning produced by the audio-visual relationship is equally influential. In audio-visual theory, Chion coined the term *added value* to describe the surplus of synchronization [1994]. It is important to not misinterpret the term, because the meaning of the audio-visual composite is not really added to the meanings of the sound and the image. On the contrary, it tends to override those meanings.

In experimental psychology, Kubovy & Schutz showed that the aural discounts the visual and the visual discounts the aural based on concepts of causation [2009, 2010]. They coined the term *ecological fit* to describe how automatic interactions between the senses draw from those concepts. They demonstrated this with a study about the perception of a percussive action, recorded on video. The study involved the image of a marimba player, a marimba sound and a piano sound. When sound and image were desynchronized, the perceived marimba sound was shortened so as to coincide with the visible impact, but the piano sound was perceived in full length. Moreover, the marimba sound was shortened when preceded by the visible impact, but not when the stimuli sequence was reversed.

The greater is the ecological fit, the more we ignore any diverging sensory information. We can explain this in terms of "cognitive efficiency". A high level of fit leads to integrated perceptual encodings and representations, which require less neural activity than separated encodings and representations [Brown and Boltz 2002, Boltz 2004]. Drawing from perception science and audio-visual theory, we conducted a study on perceived audio-visual relationships [Sá, Caramiaux and Tanaka 2014]. It led us to distinguish three levels of ecological fit:

- **High fit** means that the audio-visual relationship conveys conclusions about causes and effects. Perception prioritizes information that converges with those conclusions, producing integrated mental representations. High fit is of low intensity, because it requires little cognitive processing.
- **Medium fit** means that one senses causation without understanding the base cause and effect relationships. It is of medium intensity and requires a medium level of cognitive processing. It conveys perceptual chunking, but the process of audio-visual binding remains ambivalent: one can form integrated as well as separated representations of the sounds and the images.
- **Low fit** means that perceptual binding is weak because the sound/image pairing does not activate previous memories of causation. Discerning an audio-visual relationship requires perception to create new chunks of memory, with a large amount of cognitive processing. That means high intensity.

High ecological fit can be illustrated with Norman McLaren's abstract animation film *Dots* (1940),[16] where sound and image are synchronized one-to-one. The visual elements consist of dots, which McLaren painted directly onto clear frames of film. The sounds were created in the same way, with dots painted directly into the area on the filmstrip usually reserved for the soundtrack. Another good example is *Noise Fields* (1974),[17] a fully synchronized video by Steina and Woody Vasulka. Made with video processor machines, this work visualizes and sonifies the deflected energy of the electronic signal.

Beyond film and video art, many systems and instruments were designed to emphasize the union of audition and sight through one-to-one synchronization. The *Ocular Harpsichord* created by Louis Bertrand Castel (1730) is an early example. It consisted of a harpsichord with colored glasses and curtains; when a key was struck, a corresponding curtain would lift briefly to show a flash of corresponding color [Moritz 1997]. As a contemporary example, creative practitioners working with 3D positional audio-effects are usually keen on how these technologies create a high audio-visual fit. Tarik Barri's *Versum* (developed since 2008)[18] is an example. The digital 3D environment is seen and heard from the viewpoint of a moving virtual camera. Controlled in real-time by means of a joystick this camera moves through space, similar to how first person shooter games work. Within this space,

16. http://vimeo.com/15919138

17. http://www.fondation-langlois.org/html/e/page.php?NumPage=483

18. http://tarikbarri.nl/projects/versum the author places objects that can be both seen and heard, and like in reality, the closer the camera is to them, the louder one hears them.

The perceptual effects of medium ecological fit were demonstrated in our study about audio-visual relationships, mentioned above. An audio-visual mapping exhibiting medium fit is what we call a *fungible mapping*. It combines synchronized and non-synchronized components, exhibiting complexity enough to be confusing. In our study, the participants were aware of a causal relationship, and aware of not distinguishing the base cause and effect relationships. As they could not segregate converging and diverging information, their sense of causation extended to the mapping as a whole.

It is worth mentioning that this study was greatly motivated by the development of an audio-visual instrument,[19] which combines an acoustic string instrument and software that uses a game engine with 3D positional audio-effects [Sá 2013, 2014, 2017]. The study clarified how we could confound the cause-effect relationships despite the technical platform, which is intended to maximize the audio-visual fit. Also, in performance the relation between physical gesture and instrument output is sometimes synchronized and other times not. And we use two stereo systems crossed in space, which blurs the relation between the visible sound emitters on the screen and the corresponding sounds emitted through the loudspeakers.

Another way of creating medium fit can be found in the performances of *Sensors Sonics Sights*[20] (SSS) [Tanaka 2014]. The trio uses ultrasound sensors to modulate 3D imagery, while the sound is produced with a Theremin and the Biomuse, an instrument that operates based on EMG biosignals. The audience is likely to sense a causal connection between the performers' gestures and the sonic/ visual outputs - it truly exists. Nevertheless, the nature of the instruments confounds the base cause and effect relationships. There is no technological connection between sound and image, but points of sensory unison convey perceptual binding. As perception doesn't segregate the elements that produce a sense of causation from the elements that do not, the feeling of causation extends to the audio-visual relationship as a whole.

Yet a different way of creating medium fit can be found in many live coding performances. Live coding is a performance practice where software that generates music and/or visuals is written and manipulated as part of the performance [Collins et al. 2003]. Usually, the code is projected on a screen so that people can see the process. Yet, the cause and effect relationships are often confounding. Alex McLean sometimes purposefully obscures his code to make it more difficult to read, while still showing some of the activity of the edits [Sá et al. 2015:27]. Another example is Thor Magnusson's *Threnoscope*, a live coding system for microtonal drone music [2014]. The digital cause-effect relationships are exposed with a graphic notation system and real-time programming code. Yet, even audience members who know the system and the programming language won't fully understand the cause-effect relationships, because the visible code is relatively high-level, and the system is complex. In other words, medium fit is also compatible with consistent synchrony.

19. http://adrianasa.planetaclix.pt/research/practiceOverview.htm

20. https://babiole.net/en/sss-sensors-sonics-sights/

It is easy to find examples of low fit between physical gesture and system output, particularly in laptop performances such as Ikeda's *Test Pattern* (2008).[21] But when we watch an audio-visual performance or a film we are driven to perceive – and imagine - connections between the sounds and images, even when their fit is low and perceptual binding is weak. Indeed, one can extrapolate meanings from video images of a summer beach coupled with sounds of a warzone, even if there is no synchrony. In any case, Tony Conrad's *The Flicker* (1966)[22] is perhaps an example of low fit in film. While the sound is steady and continuous, the visual changes are abrupt and disruptive. The image consists of only five different frames: a warning frame, two title frames, a black frame and a white frame. Light and dark frames alternate with a rhythm that has been assessed to produce after-images, seeing spots, and similar phenomena.[23]

21. https://www.youtube.com/watch?v=GPhAvyrZ28o & http://www.ryojiikeda.com/project/testpattern/

22. https://www.youtube.com/watch?v=yY5VryfCRig

23. http://www.medienkunstnetz.de/themes/overview_of_media_art/perception/5/

2.4 Performer position relative to a moving image

We can use an additional low-level parameter to characterize performances with moving images - one that summarizes how the performer's physical body relates to the image. That can indicate whether the visual focus is the image itself, or the relation performer-image. The following three types of arrangement are easily distinguishable, dispensing with illustrative examples:

- **Integrated** means that the image and the performer's physical body form a single visual scene, as happens when an image is projected upon a performer.
- **Separated** means that the image is separated from the performer, who is nevertheless visible. This type of arrangement can divide attention, or deviate attention from the performer.
- **Hidden** means that the performer is not visible. The audience does not see their agency, but knowing what type of interface is being used can influence how the work is perceived.

The way the physical setup influences attention also depends on speaker placement, lighting, audience distribution and physical architecture. Every detail counts in the audience's experience. But a parametric model should be easy to use, and we do not need to parameterize each variable independently. Instead, we can use high-level parameters to provide cues about variables that our low-level parameters do not address. Fig. 1 shows the low-level parameters from our model.

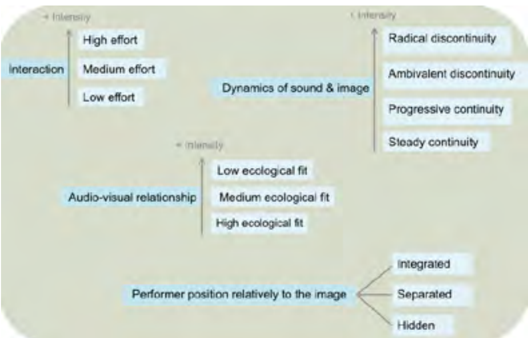

Fig. 1.
Low-level parameters that can be used to analyze interactive performances and installations, non-narrative films and animations, sound art and music, as well as audio-visual performances

3 HIGH-LEVEL PARAMETERS

This section introduces two high-level parameters, which can be used to assess how any low-level variable informs the meaning of the work, and how the product informs the feeling of presence.

3.1 Semantics

We can speak of semantics with respect to causes and concepts, but attention dynamics have intrinsic semantics as well – every experience has meaning, including when we focus on perceptual motion itself. The mental representation of the work as a whole is what we call endogenous continuity (see section 2.3).

The notion of endogenous continuity is useful to expand Jeff Pressing's semantic characterization of sounds [1997], so as to embrace the visual and the audio-visual domain. He distinguished *expressive, informational* and *environmental* sounds, stressing that these typologies are normally overlapped. Expressive sounds would include all kinds of music and song. Examples of informational sounds would be speech, alarms, and sonified data. Examples of environmental sounds would include animal calls, wind sounds, and the noises of machinery. We adapt these semantic typologies as follows:

- **Informational Semantics** prompt causal percepts, shifting attention to a meaning.
- **Expressive Semantics** means that the focus of attention is upon a central target.
- **Environmental Semantics** means a focus upon a context or environment.

These three semantic dimensions can be quantified independently from each other. We can quantify the informational dimension by assessing our conclusiveness about a cause or meaning. It might be useful to look at semiotics, where researchers distinguish three types of relation between signifier and meaning. With icons, the signifier contains something of the meaning (e.g. male & female figures on restroom doors). With indexes, the meaning derives from previous experience (e.g. smoke indicates fire). With symbols, the relation between signifier and meaning is arbitrary, so to say; it depends on convention (e.g. words). These semiotic notions respect to informational semantics, but not to expressive and environmental semantics, which also exist when the informational load is very little. Regardless of concepts and interpretations, the more attention focuses upon a specific target, the less it spreads through the environment, and vice-versa.

When analyzing a creative work, one should consider the semantics of interaction, sound, image, audio-visual relationship and physical setup. One can assess the semantics of each element, and estimate their relative weight in the global meaning of any particular work.

We consider interaction in terms of cognitive effort. Predictable, clearly perceivable interface behaviors provide a large amount of information about how the system should be interacted with; that is why the interaction is effortless. A system that does not depend much on real-time control is effortless as well, but the informational load of the interaction is little, as the audience does not perceive to which extent the performer is influencing the system output. Furthermore, perceiving effort implies interpreting causes and meanings. Also, perceived effort tends to attract attention, supporting expressive semantics.

Sounds and images have informational load whenever they evoke something beyond themselves. Symbolic systems such as programming code might provide a large amount of information if one understands the code, and very little if one does not. In other cases, the informational dimension can support the expressive or the environmental dimension. For example, a piano recording leads us to imagine a piano and a pianist, and the recording of singing birds evokes a natural environment. Semantic categorization might be less obvious in narrative film. Leo Braudy established a useful distinction between what he called "open film" and "closed film": "In the closed film there is no escape from the logic of actions and events, while in the open film characters may well walk off the frame to some section of the world the camera specifically does *not* define" [1977]. A wide shot provides all the information necessary to interpret the image, leading attention to focus within the limits of the frame. Conversely, a close-up does not describe a scene, leading imagination to build what is not seen within the frame. Thus, a wide-shot of a landscape can be expressive, and a close-up of a person or object can be environmental.

The dynamics of sound and image have their own semantics, be it expressive or environmental. To parameterize dynamics we use the taxonomy of continuities and discontinuities. Steady and progressive continuities create a sense of environment because they fulfill expectations, requiring little cognitive processing; attention can draw to the context/ environment. Ambivalent discontinuities also leave attention under individual control, but they entail more pathos; they attract more attention, reinforcing the expressive dimension of the work. Radical discontinuities make expressive semantics very strong: they prompt automatic attention, monopolizing conscious awareness. Driven by primary instincts, cognitive processing focuses on detecting, perceiving and responding to events in good time.

The informational load of the audio-visual relationship is proportional to its ecological fit, which determines the strength of perceptual binding. This is because binding is informed by concepts of causation [Kubovy and Schutz 2010], which have informational load by definition. Low audio-visual fit provides little information about causation; that is why binding is weak. Medium fit conveys a sense of causation, but the informational load is not very high because one does not understand the base cause-effect relationships. Finally, a high level of audio-visual fit provides a large amount of information; that also explains why it requires little cognitive effort.

The semantics of the physical setup are also important in performances and interactive installations. The central position of a performer, a sound source placed next to him or a spotlight over him will have the effect of directing attention to a central target, conveying expressive semantics.

Conversely, the distribution of sound and light sources in space will emphasize the environment.

A performer's position relative to a moving image is equally influential. A hidden performer confounds the extent to which the work is created in real-time, which means a decrease in informational semantics. With a separated arrangement, the semantics of the physical setup are more expressive when the focus is on the performer, and more environmental when the focus is upon the spatial relation between his body and the moving image. Finally, the semantics of an integrated arrangement can be expressive or environmental. They are environmental whenever the visual output functions like a stage scene, and expressive whenever the physical scale of the work equals that of the human body.

Sometimes, the semantics of the system output are highly expressive due to sonic and visual discontinuities, while the integrated arrangement brings an environmental quality to the work. An example is in Ikeda's *Superimposition*[24]; the performers are in front of a large visual projection, surrounded by multiple video monitors. Another example is in a performance by Metamkine at the Lausanne Underground Film & Music Festival (2012).[25] The performers sit in front of a large projection, using a Super 8 camera, color filters and various devices to create a multitude of light effects and noises. In contrast with these two audio-visual performances, Guy Sherwin created a series of silent performance-films where the integrated arrangement creates expressive semantics, and the image exhibits continuity. In these works, called *Man with Mirror* (1976-2011)[26], he forged a kind of exquisite corps by exploring the relation between his physical body and the changing angles of its reflection on a live-manipulated mirror.

24. https://vimeo.com/49873167

25. https://www.youtube.com/watch?v=xWwVvICGeR4

26. https://vimeo.com/31609396

3.2 Performative arena

To complete our parametric model we need a final parameter: one that summarizes how the different semantic dimensions of a creative work intertwine so as to shape the performative arena. This high-level parameter would hardly provide a useful means of analysis if it were considered alone; it would be too subjective. Its role is rather to complement the other parameters, and facilitate the disambiguation of certain aspects. In addition, it can provide cues about elements that have no direct representation, such as the placement of speakers and the lighting.

We distinguish three types of performative arena, which are not mutually exclusive:

- **Local arena** means a focus upon the performer. Expressive semantics are dominant.
- **Distributed arena** means a focus upon the environment. Environmental semantics are dominant.
- **Extended arena** means a subjective sense of presence beyond the physical performance space. It requires perceptual cues, which imply informational semantics.

The local arena relates to Ciciliani's notion of "centripetal" performance tendencies, where the focus is upon the performer [2015]. An unequivocal example is when a sound source is placed next to a musician. Another good example is a video from Sherwin's *Man with Mirror,*[27] where he integrates his physical image and its reflection on a mirror by using a light projector in a dark room, without any light reflections on the wall. The expressive scale of the work is reinforced with informational load, as the interaction is clearly perceivable. Furthermore, a large visual projection can convey the local arena as well. It happens when the performer is separated from the image and the image shows their interaction with the system. An example is in an expanded cinema performance by Arnont Nogyao (2017),[28] where the visual projection shows his interaction with the modified surface of a vinyl record.

The distributed arena relates to Ciciliani's "centrifugal" performance tendencies, where the focus is upon space and context [2015]. A clear example is in Niblock's performances, which create immersive environments. His drone music is played through multiple loudspeakers distributed in space, and the eyes are directed to large visual projections rather than to the performer, who sits in darkness.

The models of Birnbaum [2005] and Ciciliani [2015] consider the relation between the physical and the psychological space of a creative work, but they do not address how the work might expand one's presence beyond the physical space. Shifting spatial presence beyond the physical space requires perceptual cues, derived from the informational load of the sound, the image, or the audio-visual relationship. An example of the extended arena is in Vasulka's performance dedicated to Nam June Paik,[29] where the imagery recalls real-life situations: trees shaking in the wind, Vasulka playing the violin, Michel Waisvisz playing The Hands. Another example is in *Versum,*[30] the musical 3D environment created by Tarik Barri.

The local and the distributed arena are often combined. In Lucier's *Music for Solo Performer,*[31] attention is driven to the performer, who sits still in a central position, using his brain interface to activate percussion instruments. At the same time, attention is driven to the environment, because the instruments and the loudspeakers are distributed in the room, amongst the audience. Another, imaginary example would be a performer carrying a TV monitor displaying footage from the surrounding environment. Indeed, the distributed arena does not require a distributed physical setup. Furthermore, a creative work can combine all three types of arena. For example, Mick Grierson created a 3D composition and improvisation system that uses adaptive algorithms; it looks and behaves like first-person computer games [2007]. We can speak of a local arena because the performer is visible and the interaction design draws attention to their skills. We can speak of a distributed arena because the system takes advantage of a multichannel audio system. And we can speak of an extended arena because the system looks and behaves like a first-person video game – it extends the sense of presence to the digital world.

27. https://vimeo.cotm/31609396

28. https://vimeo.com/242720751

29. https://www.youtube.com/watch?v=9mg1weOHWSs

30. http://tarikbarri.nl/projects/versum

31. http://daily.redbullmusicacademy.com/2017/05/alvin-lucier-music-for-solo-performer

As a conclusion, we should note that the three types of arena reflect the three semantic typologies but the inverse is not necessarily true. For example, in Steina Vasulka's performance there is no local arena because the performer is not visible, yet the visual discontinuities and sonic deviations create expressive semantics. Similarly, there can be environmental semantics without the arena being distributed or extended; a sonic mass of drones emitted through a single loudspeaker illustrates the idea. Also, the semantics of an audio-visual performance can be informational without the arena being extended, as happens in Magnusson's performances with the Threnoscope system. Indeed, the parameters in our model are intended to complement each other.

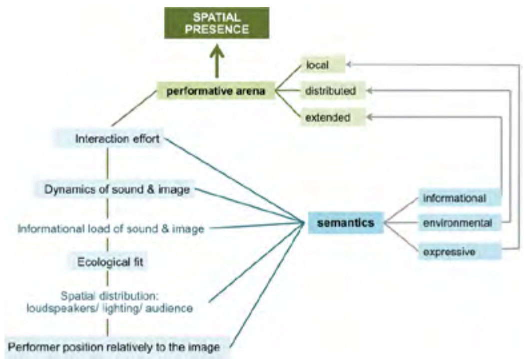

Fig. 2.
Variables that influence spatial presence. The blue-shade items have direct parameterization. The blue-font items can be inferred from the high-level parameters - semantics and performative arena.

4 FURTHER RESEARCH

The combination of low-level and high level parameters in the same analysis model offers several advantages. The model provides methods to analyze each variable in particular, and methods to interpret their relationships.
The methods are straightforward when considered individually, but their combination is complex. This makes it useful to represent all parameters graphically, with a set of axes. In practice, the integrated parametric visualization model has been very useful to the analysis of different performance languages, as well as to the development of an audio-visual instrument. Detailed information can be found at http://research.gold.ac.uk/19431/ and http://adrianasa.planetaclix.pt/research/practiceOverview.htm.

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Approaches to visualise and critique algorithms for ethical scrutiny

Keywords
visualization
algorithms
ethics
machine learning
computer vision
surveillance
decision-making

This arts research project addresses the domain of obfuscation and ethics in algorithms, including computer vision and machine learning systems. The work presents a series of simulations as visual-critical arguments, proposed as methods to open the algorithmic black box to visualize and think through the meaning created by algorithmic structure and process deployed in ethically sensitive spaces. The project seeks to provide access to and elucidate the abstraction and obfuscation at the heart of algorithmic systems.

1 INTRODUCTION

A series of visual-critical simulations aims to bring arts knowledge to bear on the intersection of computation and ethics, using critical theory and creative coding to affirm computation as a site of the social and political. The paper presents two different approaches to visualising and critiquing computational ideas and algorithms to think through questions about aesthetics and social issues.

2 CELLULAR AUTOMATA, SURVEILLANCE, AND CREATIVE CODE

The first method presents an approach to reverse engineer a social issue, in this case, surveillance, back through a particular algorithm, or core computational concept, in this case, a cellular automaton. There is a line, conceptually and visually, to be drawn between the core computational logic of cellular automata, via image processing techniques, through computer vision algorithms, and into the gaze of a street surveillance camera. The approach seeks to make this argument visually, through a series of simulations. Contextually, this research begins by looking at open source algorithms and libraries and thinking through the social and political implications of them, addressing algorithms, not just as cultural artifacts but at the level of code syntax. Connecting to the practice of critical code studies, which looks at source code as also being a cultural text with the same potential for humanistic interpretation as other cultural texts, the work uses the OpenCV library.

There is an affinity between cellular automata and images through the computational grid system of cellular automata and the pixel array structure of digital images. A cellular automaton is a system of simple rules and states, operating on grids of cells, and from such seeming simplicity, complex behaviours emerge, leading to further-reaching possibilities. State is usually represented by black and white coloured cells, which are often interpreted as alive and dead, whilst a typical rule set might be: if a live cell has less than two live neighbours, then it dies (interpreted as isolation); if a live cell has more than three live neighbours, then it dies (interpreted as overcrowding); if a dead cell has three live neighbours, then it comes alive (interpreted as reproduction); otherwise a cell stays the same (interpreted as stasis). From such a seemingly simple computational system, far-reaching speculations have been developed in relation to artificial life and the computational universe.

A Langton's ant is a version of a cellular automaton in which only one cell in the grid changes at a time, so it functions as an autonomous agent. This agent was applied to a satellite image of a location in the Amazon known as the 'Meeting of the Waters', which is the confluence of two rivers, the darker coloured water of the Rio Negro and the sandy coloured water of the Amazon River. Due to each river's different water density, speed, and temperature, their waters do not mix for several kilometers and instead run alongside each other inside the same river channel, demarcated by their different colours. Several hundred Langton's ants were deployed across the structure of the image, using its data structure to compute across, generatively repatterning it, and transforming the landscape and the composition of the river. The choice of image works analogously, where one's understanding of the landscape is terraformed by the agents. This visualization is presented in two formats, one which foregrounds the algorithm's interpretation of the scene, as a simplified four-state grayscale image that the agents use to compute on to determine their state and change pathway. Another image foregrounds the human view, as the effects of the generative redesign of the landscape. The work is presented in this way to think through the difference between the simplified data and logic that the algorithm operates with, and the higher-level image that we see, and which might hold cultural or social meaning.

Continuing this mode of visual-critical argument to connect the logic of cellular automata computations to our social understanding of surveillance, the research engaged with image processing techniques, which are an important part of a computer vision library of algorithms. Images need to be heavily processed, broken down and simplified to be interpretable by an algorithm. Popular filters such as blur, sharpen, and edge detection are used and operate with similar logic to a cellular automaton. When background subtraction is applied to an image from a surveillance camera, the image is reduced in complexity to just two states and two rules, if a pixel's RGB value changes between video frames it is assigned white, and if it remains the same between frames it is assigned black. In this way, an algorithm reads motion in a video image, and the result is a rather sinister image of the surveillance camera's gaze, tracking people walking in urban space. The research works with a creative coding approach to creating a series of visualizations of the algorithm in action, first of all isolating motion in the image, and then printing only that motion. The work uses the image of a chameleon, because of the nature of the animal to conceal itself through stillness. By analogy, the chameleon reveals itself to the algorithm through movement and camouflages itself from the algorithm through stillness.

This arts research seeks to move forward from the tradition of data visualization, to experiment with ways of visualizing computational process or models, to open the black-box of algorithms that are used in socially contentious spaces and think through their inner workings by means of visual-critical arguments. From a computer science perspective, cellular automata systems are understood as expressions of foundational computational concepts including state machines and formal logic, they are also understood as neutral mathematical concepts, however, from an arts research perspective, the very foundations of computation and code can be questioned and contextualized within a social context.

3 MACHINE LEARNING, ETHICS, AND INTERACTION DESIGN

A second approach to building visual-critical arguments to address the ethics of algorithms has also been explored. Machine learning algorithms were investigated because of their emerging use in ethically sensitive spaces such as policing and welfare. The incidents of algorithms arriving at racist or sexist classifications or being used to determine who goes to prison and who receives leniency, have received important attention over the last few years. The ethical dilemmas that are arising from the use of machine learning algorithms include the likelihood of them generating mistakes and of augmenting biases hidden in data. The investigative journalism organization, ProPublica, investigated machine bias in the US justice system in 2016, pointing to how predictive systems can encode racial bias when used in criminal sentencing, and it was from there that this research began (Angwin, 2016).

However, initially on looking into and working with machine learning, another related phenomenon captivated the direction of the research: the new emergent type of computation that has come to the fore through the rise in machine learning practices, specifically deep learning. Through machine learning, computation has shifted from a system of pre-programmed rules that are executed iteratively, into a form of generative code in which an initial algorithm, written by a human, writes its own algorithm, from which humans are precluded from understanding its logic. This has been referred to as algorithms operating in the wild.

At face value, there is something fascinating and seductive about this new computational paradigm. However, it presents an ethical issue known as the interpretability problem, in which an increase in accuracy creates a simultaneous decrease in human readability. The sensitivity around the use of algorithms to make potentially life-altering decisions is exacerbated by "AI's Unspoken Problem", described by Will Knight as being that an algorithm cannot tell us why it made the decision it did, it can only present it's predicted answer to a given question. The algorithms that are currently in use, do not have the quality of common sense or awareness of context incorporated into their models, and the need to ask an AI 'why' and receive an explanation is necessary for us to work in collaboration with them. (Knight, 2016) From an ethical vantage point, the idea that we deploy a system into an ethically sensitive space and cannot say how it works precisely, or how it arrives at a particular decision, requires a level of trust that has not been earned by such flawed systems. There is no right of appeal, of disputing the outcome of an algorithm, or asking why the algorithm arrived at a particular decision. When that decision is to recommend a person be jailed, or fired from a job, or refused a place in a state-funded drug rehabilitation program, it becomes a significant ethical problem.

From an interdisciplinary design research perspective, a framework to critically study algorithms needs to provide access to algorithms for observation, to promote literacy, enable reflection, and formulate a critical and ethical position in the discourse. An interactive visualization tool was developed to visualize a simple machine learning algorithm, a decision tree classifier, to think through some of these ideas and pose further questions. Classifiers were generated using the scikit-learn library and then rebuilt in Unity, a game engine, to drive an interactive visualization in real-time. way to temporarily isolate the meaning in data, to think about the meaning of structure and process in the algorithm instead. From a design perspective, a combination of tactics from interaction design, generative design, and to some extent critical code studies, have been employed. A decision tree classifier was used because it is one of the simplest types of machine learning that is already somewhat graphic, and whilst it is a form of machine learning, it should be noted that it is not deep learning, which is where some, but not all of the controversy lies.

The design tactics employed begin by mapping out the algorithm spatially, to look at its possibility space, at all of the various paths through the algorithm, and decisions that are made before arriving at a prediction. Then data is simulated through the algorithm, showing decisions being made in real time as the algorithm executes. The simulation of time is a tactic taken from some computer games, in which time can be scaled to see individual decisions being made at a slower, human scale of perception, through to a higher, emergent scale in which patterns of decisions can be seen forming. At this point, the visualization can point to mistakes in prediction, where the algorithm mis-classifies data. A user can also hover over each data point and reverse engineer the path it took through the algorithm, perhaps to see at which point it made a wrong decision and took a wrong path. The system also visualizes particular features of the data, through the physical proportions between the data points. The most popular and least popular pathways through the algorithm's network are also visualized. The prototype was built procedurally so that any classifier of the same type can be loaded and visualized, with the user interface supporting its structural self-organization, and aiding analysis.

In developing an interactive design tool such as this, the questions that come up include: to what extent visualization is an a-linguistic tool to re-engage with decision-making in prediction systems and provoke questions, where we are at risk of losing our connection to decision-making? Could visual tools be used by key workers in the field, who are expected to work with the results of these algorithms but so far are precluded for understanding their logic? To what extent interaction design, generative design, and critical code studies combine as an effective method to visualize an ethical position in algorithms? What does it mean to learn, in machine learning, and is the anthropomorphism of AI a productive analogy? The tool uses synthetic data, therefore artificially removing the social meaning from the data, and whilst the research is primarily motivated by that, it is in the hope to explore the concept of bias augmentation, which speculates that where there is a small bias in a dataset, this can become amplified through the iterative algorithmic process. Where most people today argue that bias is in the data, because the data is a reflection of bias in society, there is also speculation that the algorithm in its structure and process, can play its own role to augment bias. That is something to explore further, hence the focus on structure and process over data so far.

4 COMPUTATION IS POLITICAL

In his book *Ethical Programs*, James J. Brown Jr conceives of computational networks as swarms: entities without a face, without a front or center, dispersed, in constant communication, and able to attack from all directions. Unclear when it is an ally or adversary, Brown asks how we can conceive of the other that has no face, that resists representation and understanding, that is always here and yet we can't make sense of it. "How do we deal with an other that has no face, what is an ethics in the face of the swarm? (...) What rhetorical actions are possible?" (Brown, p.4) Brown proposes that new ethical programs need to be developed to address the ethics of existing inside the swarm, an ethics that likewise needs to be brought to bear on machine learning algorithms, which we should consider to be hostile, faceless, and permitting their own agency. Our understanding of trust, permission, and accountability has not been updated in line with an understanding of this new type of computation.

Steven Shaviro likewise critiques computation in the context of complex adaptive systems for masking the essential process of decision-making at its core. When decisions in systems are hidden, causality is dissolved, and accountability cannot be traced. For Shaviro, an uninformed approach to complexity and computation is often used as an alibi for an unaccountable subject that refuses participation and political engagement. Shaviro proposes to foreground "an aesthetic of decision, instead of our current metaphysics of emergence," (2009) to disentangle accountability in computational systems.

We can also look to the field of encryption, for further affirmation on why access, interpretability, and critique is an ethical argument for why we need to read the code. In Bruce Schneier's book *Secrets and Lies: Digital Security in a Networked World*, he presents the case for why it is important that encryption algorithms are in the public domain. In cryptography, when an algorithm's code is open source, it means that a significant number of people will have studied the algorithm and identified flaws, weaknesses, and possible hacks, which lead to continual updates and a stronger algorithm literally meaning that the more eyes that have looked at an encryption algorithm, the more secure it will be. Whereas, when algorithms are black boxes and protected by intellectual property, the code has not been scrutinized by many people, leaving it open to hidden flaws. (Schneier, 2000) This is an attitude we can take into the field of artificial intelligence, to argue for policy to ensure that in ethically contentious spaces, algorithms need to be available to as much public scrutiny as possible to ensure ethical robustness.

In his book *Virtual Migration*, A. Aneesh puts forward the concept of "algocracy - rule of the algorithm, or rule of code" (2006), which is described as a new kind of power that is created through the way that algorithms are embedded in software. It is a system which does not require monitoring through traditional surveillance systems, hierarchies, and forms of government, but instead governance and surveillance take place through the design of the algorithm and the ways it tacitly shapes behaviors and asserts authority, without public awareness. If we accept the role algorithms play, that their design can be a form of tacit governance, what would it mean to design an algorithm more comprehensively and consciously, with the scope of critical thinking that comes from the arts and humanities and social sciences? What if algorithms were not written solely by computer scientists, but designed by such an interdisciplinary team?

This research questions how aesthetic language and critical thinking from the visual arts can be brought to bear on algorithms and society? The research proposes to move toward a perspective that positions code as a political language. In the creative coding community, emerging from software studies, we are told that code is now a comprehensive language for creative and authorial expression. Cannot code also be a language of critique to probe its own social and political latencies?

Fig. 1. and 2.
Langton's Ant simulation (left);
Automata I, algorithm interpretation (right).

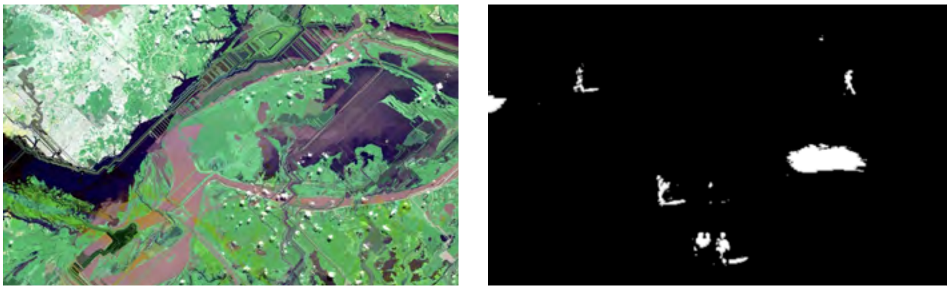


Fig. 3. and 4.
Automata I, human interpretation (left);
OpenCV library, background subtraction (right).

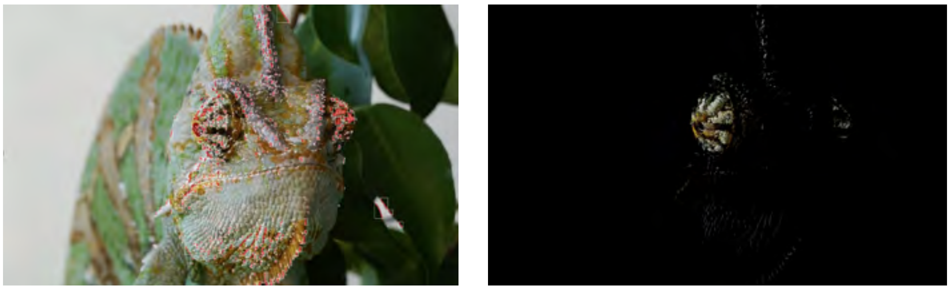


Fig. 5. and 6.
Automata II, detecting motion (left);
Automata II, drawing motion (right).

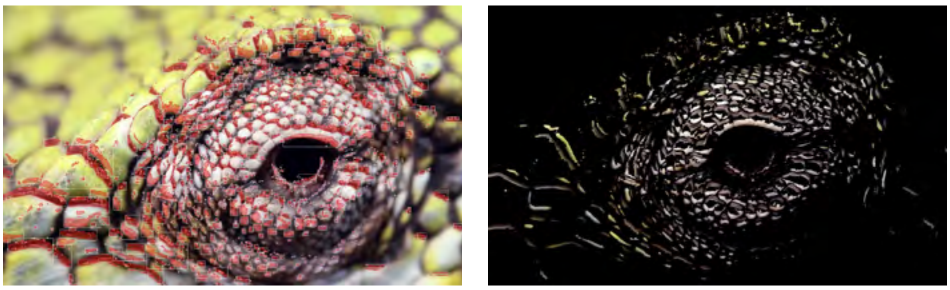
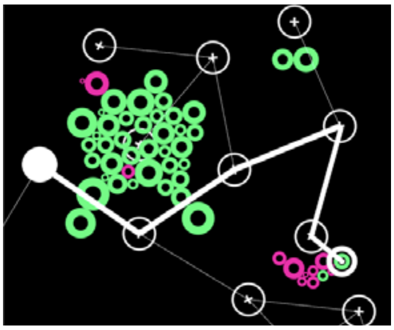


Fig. 7. and 8.
Automata II, detecting motion, close up (left);
Automata II, drawing motion, close up (right).



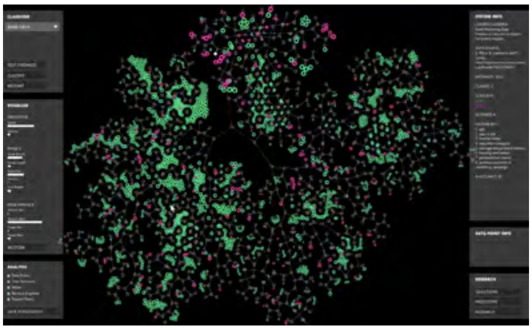


Fig. 9. and 10.
Interactive visualization tool for a simple machine learning algorithm (left); Detail of the machine learning visualization tool showing mistakes in the algorithm (right).

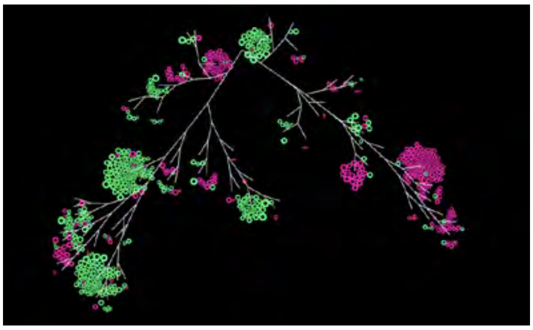


Fig. 11.
Detail of the machine learning visualization tool

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Information Diving on an E-waste Dump in West Africa – Artistic Remixing of a Global Data Breach

Keywords
E-waste
Data Subject
Found Footage
Social Engineering
Artistic Research

Consumer electronics such as smartphones and notebooks have become an indispensable part of our daily lives. The Internet of Things (IoT) is increasingly adding electronic devices onto our shopping list. Devices that are adding up to a 24h surveillance system that is tracking every aspect of our life. Through planned obsolescence the life cycle of many electronic parts that compose a product is significantly shorter than the life cycle of the product. Some obsolete devices end up in regulated e-waste centers in Europe, yet 47% of European e-waste is illegally dumped on electronic-wastelands in developing countries each year. These devices still contain personal data that can be reanimated and abused when falling into wrong hands. A research team recovered data from hard-drives bought on the biggest West African e-waste dump and shared it with a network of international artists. In a research lab, artists and researchers explored what happens to our electronic waste, what kind of data traces are revealed of the hard-drives prior owners, and what environmental and privacy threats do exist. The artistic explorations were documented in form of a publication and presented as an exhibition series that raise concerns on privacy, data security and illegal e-waste trade.

1 INTRODUCTION

The concept of remixing and recycling ideas and content that others have produced has a long tradition in the development process of human culture. Artists from various backgrounds are applying these strategies in the creation process for their artworks: In past decades experimental filmmakers such as Craig Baldwin, Matthias Müller or Martin Arnold create their collage films and found footage videos with material they bought at thrift stores, yard sales or flea-markets. The VJ-ing culture remixes online archives with real-time effects and styles like glitches or compression artefacts used in popular music-videos make extensive use of the found footage aesthetics. (Vernallis, 2013) Media archaeologists re-appropriate old technology and invent technological glitches and alternative histories of human-computer interaction. (Sommerer, 2015) Contemporary musicians and sound artists are circuit-bending electronic toys or other low-powered devices to create sound generators and effect synthesizers. (Navas, 2014) Street artists and media activists remix commercial or political advertisement for culture jamming practice and other forms of guerrilla communication. Manovich argues that most human cultures developed by borrowing and reworking forms and styles from other cultures, like the ancient Romans remixed the ancient Greek culture. (Manovich, 2010) The convergence of media, the creation of creative commons licensing and Web 2.0 platforms enable to collaboratively edit, remix and share content, and to critically engage with popular culture by revealing social engineering, endemic racism, sexism, and homophobia. (Fagerjord, 2009; Horwatt, 2009) Analysing, reusing or recycling material that others discard can also reveal personal perspectives into one's live. With the social engineering practice of 'dumpster diving' people search for identifiable information, with the intention to collect sensitive information about a company or an individual:

> Most people don't give much thought to what they're discarding at home: phone bills, credit card statements, medical prescription bottles, bank statements, work-related materials, and so much more. (Mitnick, 2011)

A.J. Weberman, a self-proclaimed "garbologist", collects, analyzes and archives Bob Dylan's trash since the 70s. As a fan and avid dumpster diver, he waded through his trash in order to gather scraps of evidence to support his interpretations of Dylan's lyrics. (Marshall, 2018) The self-recorded phone conversations with Dylan unveil the musician's discomfort when an unknown person gains insight into the private life by analyzing their trash. Based on these findings, Weberman published a 'Dylan to English Dictionary' and exhibited his former belongings at the Yuppie! Museum in New York City. (Zimring, 2015)

Rather than snooping in the trash of one famous individual the archaeologist William Rathje broadens the dumpster diving approach in the "Garbage project" and analyzes waste dumps of US-cities to gain insights into people's living habits. (Rathje, 2001) Through mobile Internet people share unconsciously sensitive information like geolocation, browsing habits or personal preferences with marketers. This online tracking also happens in the browser, where companies get a personal insight into our interests, likes and behavior. (Jansen, 2016) Once a service provider gets hacked, personal information can be exposed, data breaches like the Ashley Madison data dump exposed affair-seekers or leak login information to millions of email-accounts. (Brownlee, 2015; Onaolapo et al., 2016)

Propelled by constant technological innovations of consumer electronics paired with faster life-cycles of the smart devices', consumers produce an increasing amount of e-waste each year. If these obsolete gadgets don't get properly recycled, sensitive information and personal data-points can still be found on the devices:

> Some people will not wipe their hard-drives and obviously if you dispose of that computer it can be accessed by criminals, ... The problem is many of them don't know where they're ending up. (Ensor, Gray, 2012)

In the recycling process, our abandoned electronics go through many vendors who can easily access and exploit our data. Even when exporting e-waste is regulated by the Basel Convention regarding "Control of Transboundary Movements of Hazardous Wastes and Their Disposal", traders use loopholes such as labeling not functioning consumer goods as "second hand" and "third world help" giving the intention to help to bridge the digital divide. An investigative journalist team from Germany tracked the route of two TV-sets equipped with GPS devices from a German buyback center to the street markets in Nigeria and the Agbogbloshie e-waste dump in Ghana. (Braun et al, 2015) Examples like this makes it clear that we do not have control of what happens to our obsolete hardware and as this paper shows few of us have the technical skills to properly delete data making it sure that it is unrecoverable. As artists, when dealing with data breaches, such as the recovered hard-drives three initial questions emerged. This paper makes the following contributions:

- It provides an overview of the acquisition process of hard-drives from an e-waste dump in West Africa.
- It lays out main research question that were explored in a practice-based artistic research lab:
    - What ethical issues are participants confronted with when treating the data as found footage material for artistic production?
- It explains main parts of the research lab activities, such as: the organization of a symposium and an ArtLab, editing of a publication and curating an exhibition showcasing artistic case studies.

The paper concludes with limitations of the study and provides an outlook on future research.

2 MATERIAL: INFORMATION DIVING IN WEST AFRICA

We as the KairUs collective (authors of this paper) visited one of the biggest and most toxic electronic-waste dump sites in the world, Agbogbloshie in

Accra, the capital of Ghana. (Bernhardt, Gysi, 2013) A local guide took us to the Agbogbloshie dump-site where we witnessed ongoing recycling processes like the arriving of containers full of e-waste from the Tema shipyard, the main harbor of Ghana. At the e-wast dump people mainly try to reuse, repair or recycle functioning components; still, due to a lack of technical equipment, the recycling process is very limited but very toxic for the workers and the environment. Almost all electronics reached their end-of-life state, and by dismantling the devices, components like power packs, batteries, CPUs, storage mediums, casings, motors and circuit boards are collected and sold in bulk. (Oteng-Ababio et al, 2016) Parts that cannot be used or sold in this separation process land on the ground where teenagers handpick cables and PCB parts or use loudspeaker magnets for collecting tiny metal parts. (Caravanos, et al, 2011) This way the scavengers try to extract valuable metals like copper, gold, silver or aluminum from the precious dirt on the ground. Besides this physical separation of e-waste, recycling components and metals, some recyclers search for sensitive information on old hard-drives in order to exploit and harass the former owners. (Warner, 2011). This made us curious to tryout if it is actually possible or how easy it would be to recover data from a discarded hard-drive from the Agbogbloshie e-waste dump. (Kirschenbaum, 2008) Therefore we talked to different recyclers who were extracting hard-drives from desktops and laptops and were able to acquire 3,5" and 1,4" hard-drives for each 10.- respectively 20.- Ghana Cedi (about €2.20.-/€4.40.-, Jan. 2019). In total, we bought 22 hard-drives from varying manufacturers, year of production and storage capacity. None of the sellers could guarantee that the hard-drives were still functioning, so what we could do is to check that the hard-drive pins were not corroded or broken, and that the drives were in an overall decent condition.

2.1 Artistic research lab model: ArtLab - publication- exhibition

Returning to Europe, we proposed a 'data remix' workshop to servus.at, a Linz based internet culture initiative that operates an artist-run data center and who also organizes the biennial art festival *Art meets radical openness* (AMRO). Together we extended the workshop proposal to a funding application for an artistic research lab that would run for a two-year time-frame between two festival editions. The proposed ArtLab was to serve as an incubator where artist groups are provided with resources for their research and artistic production. Topics such as data mining, data security, illegal e-waste trade in relation to the growing Internet of things shall be discussed in a symposium with experts and artists. Recovered data was planned to be shared with artists who would reflect in their artistic practice on the topics discussed in the symposium. In this process a set of research questions were established:

- What do participants expect to recover from the hard-drives?

- Would these hard-drives contain personal data that can be potentially exploited?
- What kinds of questions rise in terms of privacy and ownership of the recovered data?
- What ethical issues are participants confronted with when treating the data as found footage material for artistic production?

Inspired by the open-source movement and remix culture where source material is often re-appropriated by various users in different ways, the plan was to recover data from the hard-drives and redistribute it to a trusted network of artists which became co-researchers and contributors and remix recovered data for production of artworks. Hence an interdisciplinary group of artists came together each with their own perspectives on the data and the underlying problems of illegal e-waste trade and data leaks in second-hand recycling life-cycles. Through this participatory act, the authors gathered an interdisciplinary group of artists, each with their own perspectives on the data and underlying problems of illegal e-waste trade and data leaks in second-hand recycling life-cycles. When the project started the intention was to present the outcomes of the ArtLab in a publication and an exhibition. Early in the process it became clear that the interdisciplinary approach was engaging artists with various skill sets to discuss and reflect on the topic, yet a lack of both technical and experiential expertise in the chosen topics became a blockage for some of the artists to continue with the collaboration. From these challenges developed a model in which the ArtLab served as a kick-off event refining research questions through practical experiments and discussions. For the planned publication, the authors collected artists working with e-waste, hard-drives and more generally investigating critically aspects of saving and erasing data. Consequently, in such a combined artlab-publication-exhibition model the ArtLab and the publication served as preliminary research for curating the exhibition enabling us to gain both the technical competence as well as a wide range of interpretations and provocations of the subject itself.

2.2 Preparations: Recover data & redistribute

A first step in providing artists with data from the hard-drives was to reanimate the data in order to make it accessible. In an initial attempt, all the hard-drives were hooked up to a PC with a commonly available hard-drive adapter. In this way it was immediately possible to access data from five of the hard-drives. Data on four of these five hard-drives had not been deleted by the former owners, making it easy to create a recovered data image on a separate, external hard-drive. The fifth hard-drive's data was recovered using readily available open source programs 'Photorec' and 'Testdisk'. Additional deleted data was also recovered from the other four hard-drives with the help of the software. The remaining seventeen hard-drives were handed over to a collaborating data-recovery company where professional technicians were able to restore one more of the hard-drives. Most hard-drives were 8-12 years old so the company couldn't provide the necessary replacement parts for the broken components. Since we wanted to investigate the easy attempts of data breaches we decided to not further investigate the broken hard-drives, and rather focus on the ones where the data was easily accessible. In total, about 85 GB (229.446 items) of personal data was recovered from the six hard-drives. During the recovery process, members of the ArtLab contacted artists who expressed interest in becoming co-researchers in the project. Six European artists from Norway, Netherlands, Germany, Hungary and Switzerland were selected, aiming for a diverse mix of young, emerging artists working with various mediums; sculpture, sound/noise art, video-art, performance, and installation. Also invited were Austrian artists and students from the University of Art and Design Linz to participate in the process. In order to bring all participants together a symposium was organized with talks by invited experts and an extended ArtLab weekend that served as a kick-off event for the collaborative artistic research. One month prior to the event involved artists were provided with the recovered data. Local students just copied the data; international artists received the data through the internet net-culture hub's FTP-network. The participants had a first look at the data and were able to develop their own sorting and categorization strategies from the vast amount of data available. In the meantime, together with members of the net culture team we outlined a group of experts for the symposium to speak on topics such data mining, data recovery and data forensics.

2.3 ArtLab part one: Symposium

For an extended weekend, eight international and four Austrian artists gathered for the ArtLab. The first evening kicked off with the symposium and talks from the invited experts including data broker researcher Fieke Jansen (Tactical Tech Collective Berlin), data recovery specialist Can Sintiras (ECS Global) and data forensic expert Prof. Michael Sonntag (Johannes Kepler University Linz). Can Sintiras gave an insight into the data recovery industry and his company that provides data recovery for individuals and small businesses. He explained to us about the process of when a customer needs to get data off a hard-drive recovered. In this case ECS Global technicians treat the client as the legal owner of the drive and the technicians try their best to recover as many files as possible. In order to protect the privacy of their clients the technicians won't scan the content of the recovered data for copyright violations, or illegal activities. For the hard-drives that are physically damaged the team needs additional spare-parts to replace circuit boards, firmware chips or disk heads. Since the replacement parts are often hard to find the company is always eager to buy second hand hard-drives produced by popular brands, sometimes leading to shady offers of thousands of undeleted hand-drives containing personal data of pre-owners.

Fieke Jansen from the Tactical Technology Collective talked about third party trackers and data brokers, and gave an insight into the value of public data-points and the public's role as data subjects. Companies collect data for profiling: who we are, age, gender, where we live, who we interact with, what we read, or what we're interested in. This information can then be packaged and sold to others like advertisers, other companies, or governments.

Prof. Dr. Sonntag talked about data forensics with a special focus on the upcoming ArtLab weekend. Computer and data forensics focus on obtaining evidence to be used in criminal court cases. It's about finding evidence about the history of the user, and not to assume what the user might have done or not. In forensics, you need to collect more evidence than to find one file that unmasks the criminal. The forensic scientist rather has to develop a case study with solid arguments leaving out any doubts that things just occurred by accident. Forensic investigations are all about keeping a level of integrity, meaning one shouldn't alter anything during ongoing investigations. All changes have to be documented and detectable, so from a forensic perspective, the Agbogbloshie hard-drives seemed to be useless, since there were untraceable gaps between the owner discarding the hard-drive and the time when the drives got picked up by us. This fact didn't discourage the participants from further exploring the hard-drives and using them for their artworks.

2.4 ArtLab part two: Experiments & discussions

As organizers we gave detailed insights into their ongoing research and the data acquisition process of the hard-drives at the e-waste dump in West Africa, followed by short presentations by each artist where they introduced themselves and their prior works. Each artist also outlined their main interest and concerns while looking at the data. A field trip to a nearby e-waste recycling center unveiled how e-waste is recycled in Europe, which heavy machinery is used in the process, health and security standards that have to be considered and which strategies are applied against the illegal e-waste trade. Group discussions with an emphasis on the establishing of personal and collaborative research questions were followed by hands-on experiments such as visualizing data through sonification, microscopic photo scans of hard-drive parts or attempts to reverse-engineer former owners contact details. Each participant found their own working method to carry out hands-on explorations, diving deeper into the data and trying to interpret it or reflect their concepts and ideas with other participants.

2.5 Deeper insight: Publication featuring artistic research approaches

Following the intense ArtLab, the research questions were refined and the research topic was broadened with the intention to reach out to artists who explored issues of saving, deleting and resurfacing of data. For a deeper insight we wanted to trigger a conversation among artists about their research-led practice and their discoveries in order to collect various experiences a book was published in which each chapter, introduced by a theoretical text, providing an overview and raising concerns, followed by artistic and activist strategies that exposed problematic power structures, creatively revealing how we lost control of our data and offering strategies to deal with our data in today's 'smart world'. The publication was produced entirely using open-source editing software, licensed under CC-BY-SA 4.0 and made available through the repository hosting service Github.

The first chapter focuses on 'saving' processes of our personal data and tries to unveil who collects our data, where it is stored and what it gets used for. Fieke Jansen wrote a chapter about the booming industry of data brokers who track our behavior, profile us and sell these data points. Three artists, Ivar Veermäe *Center of Doubt*, Emilio Vavarella *The Google Trilogy* and Leo Selvaggio *URME Surveillance* wrote about their artistic research methods and how they tackled issues of saving processes in their artworks. Vermeer writes about his video-based investigations of cloud computing and data centers, the materiality of the infrastructure and environmental properties of Google's data center in Saint-Ghislain, Belgium. In his multi-channel work *Center of Doubt*, he compiles several video artworks of his observations. *The formation of clouds* uses satellite images of data centers to show the competition between Microsoft, Facebook, Apple, Google and Amazon to gain the best position to run the infrastructure of our everyday, modern lifestyle.

In his chapter *The Google Trilogy*, Vavarella writes about the metamorphosis of humans becoming machines or networks, and his artistic documentation of "uncultured errors", mistakes and glitches that happen on Google's street-view before they are reported and corrected. A second project uses Street-View to collect 100 photographs called *Michele's Story*, an attempt to precariously reconstruct a single human journey and a man's tragic car accident where he became almost completely paralyzed and suffered memory damage. His third work, *The Driver and the Cameras*, merges topics of "uncultured errors" and the human factor similar to the second artwork by showing eleven faces of Google car drivers that were not automatically blurred by the algorithmic anonymizer.

Selvaggio contributes with his *URME Surveillance* project on the topic of mass surveillance and provides the public with a photo-realistic 3D printed prosthetic of his face. If multiple users were to wear his prosthetic and become 'Leos' in different areas of the same city at the same time, facial recognition systems would have conflicting locative information, through this obfuscation the 'real' Leo can hide amongst other users and therefore successfully corrupt digital surveillance networks.

The second chapter is concerned with processes of deleting data. In her text, Marloes de Valk addresses how our "information hungry lifestyles" creates the toxic lakes in China and e-waste dumped in developing countries. Yvonne Volkart examines the topic of waste focusing especially on the recycling and reusing paths of smartphones. Audrey Samson reminds us that the deleting process of data is far more complicated than emptying the virtual trash bin on our desktop or resetting our phones to the factory presets. In her artistic research data gets deleted by physically destroying the storage medium or concealing it, making it impossible to access. Through physical destruction Stefan Tiefengraber's artworks bring forth the materiality of servers in data centers and, at the same time, emphasize how limited our access to these cloud-storage infrastructures are. In his artwork *User Generated Server Destruction* visitors to a website have the rare opportunity to physically damage and, finally, destroy the server on which the website is hosted.

The third chapter focuses on the resurfacing of data. Since every aspect of our lives is somehow digitally documented, traces of our data can resurface in a number of places in various undesirable situations. This is clearly stated in Prof. Sonntags chapter when he writes about third-person data: data that gets collected, stored and analyzed without our consent. He examines what personal data exists and in what context it might resurface. In a chapter, we write in more detail about the acquisition process of the hard-drives at the e-waste dump in Ghana. The last article, also written by us, focuses on the resurfacing of fraudulent business websites. There are estimates that about 20% of the entire web consists of fake websites, often clones and copies of sites that are published elsewhere. In the article, we illustrate how 'open source intelligence tools' can be applied to report websites that are suspected of fraud and are eventually blocked by their hosting providers. Once one domain is blocked, the same website often resurfaces under another different domain name. This phenomenon is presented in the artwork *Megacorp.* that visualizes a collection of 1000 evil web companies.

2.6 Presenting artistic research: Exhibition

For the Art Meets Radical Openness (AMRO) festivals' exhibition selected participants from the ArtLab and the *Behind the smart world* publication were invited to present their artistic case studies. The exhibition was further curated through network meetings and an open-call resulting in artworks focusing on e- waste and data scraping being included in the exhibition. Throughout the festival weekend, artists organized guided tours through the exhibition and workshops by the Tactical Technology collective and a data funeral performance by Audrey Samson completed the program. In the following paragraphs we want to focus on several artistic case studies that deal with the recovered data and showcase results of the ArtLab.

Fig. 1.
a) Shell performance,
b) Shopimation,
c) DEL?No, wait!REW.

Martin Reiches' artwork *Shell Performance* (Figure 1a) is heavily influenced by data from the recovered hard-drives. The installation sifts through the masses of personal files of the unidentified previous owners of the hard-drives and transforms them into an ASCII art-inspired digital collage that focuses on audio files, documents, images and videos (mostly pornographic imagery), questioning consumerism, privacy, digital and electronic waste management and everybody's personal relationship to data and to the devices they are stored on.

The video artist Fabian Kühfuß produced a found footage collage from the browsing history of one hard-drive called *Shopimation* (Figure 1b). He arranged the fashion and lifestyle thumbnails in different patterns in sync with a catchy song he found in the music library of the hard-drive, creating a choreographed animation of the pre-owner's 'aesthetic dreams. As Flusser argues the techno-imagination is an approach of coding a function of the meaning of techno-pictures, the video animation *Shopimation* uses those thumbnails to build up the subjective code of an aesthetic. (Flusser, 2012) Built by the remaining data of an unknown person and the re-arrangement by the artist, *Shopimation* could be a code to translate the very private dream of whom the hard-drives pre-owner would like to be.

We as the KairUs collective created a trilogy of artworks called *Forensic Fantasies* (Figure 2), a series dealing with data breaches of private information. The first artwork of the series is called *Not a Blackmail* (Figure 2a) and examines the possibility to extort the pre-owner of a hard-drive. Besides finding sensitive data of the owner it is crucial to be able to contact the person to make one's demands. From one hard-drive the artists were able to trace the pre-owner, further through social media platforms, they were able to locate his current employer and other contact details. Rather than blackmailing the person, we grew curious if it is possible to get in contact with the person. Therefore, the artwork consists of one ready-to-be-posted package, containing the recovered data and a letter directed to the pre-owner.

The second artwork *Identity theft* (Figure 2b) of the series focuses on the phenomena of romance scamming. Scammers conduct identity theft by scraping images in bulk of attractive people to create fake profiles on social media platforms and dating channels. The fraudsters pretend to be in love with their victims and, after gaining their trust, lure them into fraudulent payments, always hiding behind their fake identity. One hard-drive contained several images of attractive women that showed them in everyday situations.

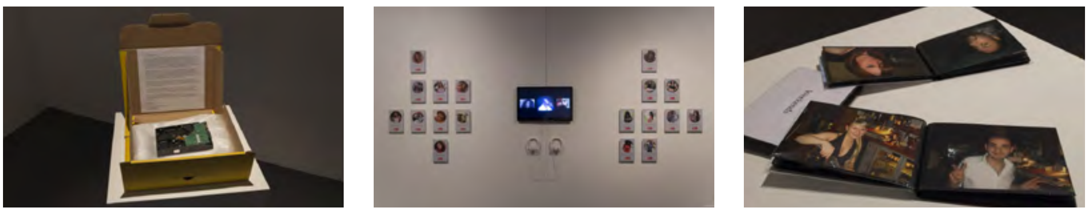

Fig. 2.
Forensic Fantasies: a) Not a Blackmail, b) Identity theft and c) Found Footage Stalker. (Photos by Janez Janša, Aksioma)

We got suspicious when we found scans of the women's passports that unveiled their multiple identities. We suspected that the images were copied to this hard-drive to create and sustain fraudulent profiles and that the women were victims of identity theft.

West African Nollywood films, mainly Nigerian and Ghanaian low-budget films, have their own way of dealing with the phenomena of scamming, which is a recognized problem in these countries. In this installation 18 of the fraudulent online profiles using the same images found on the hard-drive are combined with clips of Nollywood found footage that cover the topic of romance scams.

The third artwork, *Found Footage Stalker* (Figure 2c) of the series takes a closer look at the private images found on one of the hard-drives. Scanning through the private photos permits very personal insights into the lifestyle habits of the pre-owners of this hard-drive. Over a number of years, we follow them to wild parties with friends, trips to amusement parks and private Christmas celebrations with their family. It is similar to the feeling of stalking someone unknown online, despite the rather uninteresting photo material, one starts to create stories and attach a personality to these fragmented digital representations. By presenting photos in a classic photo album, we approach the material as 'found footage', ready for remixing and creating new artworks, something artists have done for generations. Hence the artwork confronts earlier practices of using 'found footage' and the remixing culture by using personal data found amongst our trash.

For artist Michael Wirthig the most interesting part of these hard-drives is the magnetic disc, the physical place where all kind of personal data gets saved. For his experimental film *Headcrash* he extracted the discs from two hard-drives and explores the surface with a microscope. Over 1.500 photos zoom-in on inside and outside influences of the discs; dust particles, scratches, and other physical impacts are arranged to a fast-paced film sequence.

Michaela Lakovas installation *DEL?No, wait!REW* (Figure 1c) consists of three screens, one of them constantly recovering files from one hard-drive and presenting them to the viewer on a second screen. The installation aims to prompt viewers with a decision or ethical choice whether to save the file by publishing it online or to delete the recovered file – which will start the recovery process again and presents the image to a future viewer. The published images are on display on the artist's website.

3 CONCLUSIONS

We bought 22 hard-drives on the West African e-waste dump Agbobloshie and brought them back to Europe. The initial aim was to examine how criminals can access personal information from computer hard-drives retrieved from an e-waste dump. In a practice-based research lab we were able to recover data from six of the hard-drives. The recovered data was shared with a trusted network of artists and treated as found footage, remixed into experimental videos and installations. These artistic experiments confirmed that personal data can be easily found, reused and abused by unknown third parties when data on the hard-drives is not encrypted, properly deleted, or the drive itself physically destroyed. The artistic positions, interpretations and provocations were presented in several different iterations at exhibitions and media art festivals. The study has confirmed the findings of Kirschenbaum who argues that storage mediums collected at e-waste dumps can also become vehicles for data breaches. (Kirschenbaum, 2008) Also, so-called smart technologies are based on data collection which raises privacy and data security issues. The limited timeframe that we spent on-site as well as the small sample size of 22 hard-drives did not allow for scanning of the dumped drives on a quantitative level. Additionally, this paper has described one model of a process oriented, artistic research lab that has evolved trough an altering assembly of artist and researchers bringing about interesting interactions between individuals. In hindsight, a shortcoming of the ArtLab is that no local artists from Ghana or other countries affected by the illegal dumping of e-waste were included in the ArtLab. As a spin-off project a group of participating artists created an interactive world-map called *Mapping the Smart World* which examine the life-cycles of consumer electronics and network technologies. Starting from mining of minerals, through refining of elements, to production of metal alloys, magnets, components and, assembly of consumer goods in our 'smart world'. Further, the project maps data centers that hold a key position in our everyday use of devices. In the end of the life cycle, electronic waste becomes once again a source of raw materials such as metals and plastic. This map provides a framework for the future exploration of research topics.

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Netz 2.0: Towards Site-Specific Performative Topologies

Keywords
sound installation
sonic interaction design
interaction topology
NIME

The way we perceive music, interact with musical instruments and produce music has changed. Based on new digital technologies and electronic and scientific concepts, musical instruments today differ fundamentally from traditional acoustic instruments. Thanks to micro controllers and a wide variety of sensors, there are no limits to the imagination when it comes to the design of new music instruments and interfaces for musical expression. However, this also raises new questions that go beyond the technical and sound-related evolution of interfaces for musical expression. How do we interact with these new instruments? How are they operated? Are approaches such as the traditional keyboard still a point of reference, or can the numerous possible interactions based on sensor technology and computer programming be formalised within a more contemporary classification? This article proposes a concept for analysing new musical interfaces and their interaction in a new light. It includes the description of the site-specific interactive sound installation Netz 2.0, which introduces a spider web-like instrument topology offering an interaction method based on stretching and pulling elastic strings.

1 INTRODUCTION - OLD AND NEW MUSICAL TOPOLOGIES

The creation of sound and music is closely connected to space. And as sound, also instruments themselves are often spacious, such as large organs with their high pipes, or Thaddeus Cahill's two hundred ton electronic *Telharmonium*. Another large instrument is Baastian Maris' *Fire Organ*[1], an arrangement of meter-high steel pipes in which gas explosions generate massive low frequency pressure waves, digitally controlled with just a midi-keyboard. Nowadays, even suspension bridges can become musical instruments, as implemented by the artists group *Humanharp*[2]. The *Global String* by Atau Tanaka (Tanaka 2001) is an instrument that even combines the physical and the virtual space. It reacts to vibrations, transports the information digitally through the Internet and reproduces it on a physical counterpart. Yet in all of those instruments and contemporary interfaces, interaction takes place via classical principles, like the plucking and bowing of a string, the striking of a key - musical interactions that have a long tradition, going back to string instruments such as the *Monochord* of ancient Greece or the traditional Chinese *Guqin* with a history of more than 3000 years or the African *Berimbao*. Instruments that use keys to be operated can be traced back to the *Hydraulis*, a 2000 year old Greek water organ. However, keys decouple the interaction from the sound generation and represent a tool-like extension. Those mechanisms of the instruments have become increasingly complex in correlation with technological developments. After all an essential step away from the key or string-based interaction was the development of electrophones, a new genre of musical instruments based on the use of electricity. Fascinating until today is the *Theremin*, an instrument played by the proximity of hands to two antennas. The interaction is based on the manipulation of electromagnetic fields without physically touching the instrument. Further new interactions are possible using e.g. the metal wire of Oskar Scala's *Trautonium* or the knobs and cable connectors of modular synthesizers, such as *Minimoog Model D.* Yet even Robert Moog had to add a keyboard to his *Minimoog* in order to attract the general public.

1. Bastian Maris' *Fire Organ*: https://www.vice.com/en_uk/article/aen7xe/dude-builds-flamethrowing-organ-blows-minds

2. Human Harp - 130th Anniversary Intervention, Brooklyn Bridge: https://vimeo.com/71960933

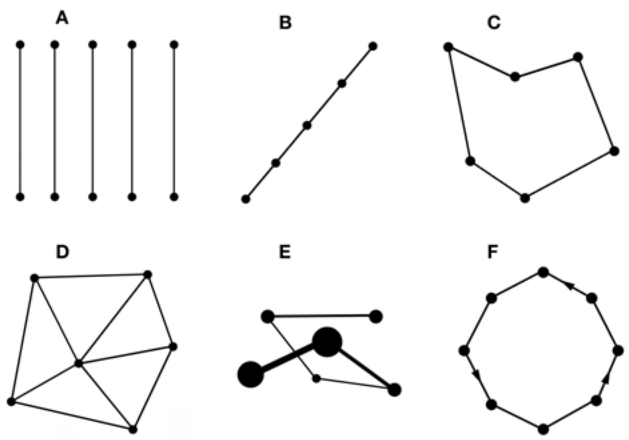

Fig. 1.
schematics of performative topologies: (A) parallel topology, (B) axial topology, (C) non-symmetric topology, (D) mesh topology, (E) three-dimensional topology, (F) circular topology

Nowadays, in digital sound production, it is the controller that links the musician and the sound production or data processing. Controllers can enable key-based interaction like the midi keyboard, fader- and knob- based interaction offered by midi control surfaces, but also three-dimensional string-based interaction with the *Gametrak*[3]. All these different controllers have in common that, depending on the controlled music software or the respective instrument, they can influence the sound generation in a freely configurable way.

3. Gametrak: https://en.wikipedia.org/wiki/Gametrak

Reviewing traditional forms of interaction, such as pressing keys or plucking strings, the physical aspects of the interaction between musician and instrument clearly shows a continuity towards modern controllers. The separation of the control unit and the sound generation, as in the case of the piano and the key, obviously still represents a convincing form of instrument design today and also remains adaptable to new developments and technologies. With modern technology, however, other types of musical interaction have also evolved, such as hand and finger tracking by the *Leap Motion*[4] or camera tracking using the Microsoft *Kinect*[5]. Being traced by the *Kinect* the entire human body and the surrounding space becomes a controller, even without physical contact to the control unit. The same applies to accelerometer-based devices such as the *PlayStation Move*[6] motion controller or the artistic *Gloves Project* (Serafin 2014). Musical interfaces that work on the basis of brain activity (EEG) completely detach the physical body from the process of sound generation. The potential of new technology seems to be endless, especially when the benefits of digital computing are reconnected into the physical domain, as Hiroshi Ishii and Brygg Ullmer suggested with the *Tangible User Interfaces* (Ishii 1997), in which physical artefacts are used to manipulate digital data representations in the computer.

4. Leap Motion: https://www.leapmotion.com/

5. Microsoft Kinect: https://en.wikipedia.org/wiki/Kinect

6. PlayStation Move: https://en.wikipedia.org/wiki/PlayStation_Move

If one considers today's totality of different instruments and musical interfaces, then the question arises how these can be described and categorised. One approach that might be useful is the concept of topology. The term is borrowed from the subjects of mathematics, geography and computer science and refers to relationships and systematic contexts. The first use of the term was made by the philosopher Johann Benedikt Listing, who in 1847 attempted to describe the Möbius band and thus reversibly deformed objects in general (Günzel 2007). In mathematics, for example, it describes qualities such as proximity and striving from one point to another or represents a set system of related subsets. In geography, the earth's surface is described based on three-dimensional data series. In electronics electronic circuits (circuit topology) are described with it. In computer science network structures are considered as topology. I would like to adapt the term to describe the configuration and the interaction of new musical interfaces and computer music suggesting the following performative topologies (see Fig. 1):

- **Parallel Topology:** traditional instruments such as the piano, guitar, violin etc. represent a parallel topology based on the string arrangement. Though also contemporary experimental interfaces such as the suspension bridge used by *Humanharp* can be considered as parallel topology.

- **Axial Topology:** Instruments such as flutes or the *Glass Accordion* (1762) by Benjamin Franklin (Hermosa 2013) exhibit an axial topology.
- **Non-symmetric Topology:** an example for a non-symmetric topology could be the free arrangement of drums and cymbals in a drum set, of which Moritz Simon Geist's *Sonic Robots*[7] represent a modern version. Likewise, the arrangement of the physical tokens on top of the *Reactable* (Kaltenbrunner 2007) or the physically engraved instrument scores at Enrique Tomás' *Tangible Scores* (Tomás 2016) could be considered non-symmetrical or open topologies.
- **Mesh Topology:** since the development of the electrical instrument a new topology appears: the mesh topology. It can be found in the networked modules of a modular synthesizer, in object-oriented musical programming languages, such as *SuperCollider*[8] or *Pure Data*[9], or even in the instrument design based on string controllers at Jung in Jung's performance project *Thermosheric Station*[10].
- **3D Topology:** Interaction based on pressure sensors and horizontal movement, e.g. *SeaBoard*[11] or *Haken Continuum*[12], could be described as a 3D topology. Likewise, projects like the *Schallmauer* (Tomás 2018), although based on physically solid material, allows touching and pressing for interaction and therefore also represents a 3D topology.
- **Circular Topology:** mechanical music devices whose playing principle is based on the turning of reels represent a circular topology, as well as other physical scores, such as barrel organs, music boxes or even band echo devices. This includes musical interfaces like the *Rhythm Ring*[13], the *BeatBearing*[14] or the *XOXX Composer*[15].

7. Moritz Simon Geist - Sonic Robots: http://sonicrobots.com/

8. SuperCollider: https://supercollider.github.io/

9. Pure Data: https://puredata.info/

10. P Jung in Jung - Thermospheric Station: http://www.junginjung.com/thermospheric-station

11. Seaboard: https://roli.com/products/seaboard

12. Haken Audio: https://www.hakenaudio.com/

13. Rhythm Ring: https://www.youtube.com/watch?v=uKtisFD3PHE

14. BeatBearing: https://www.youtube.com/watch?v=wreP8FMupyM

15. XOXX Composer: http://xoxxcomposer.axelbluhme.se/

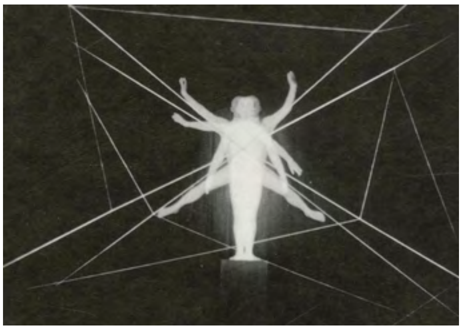

Fig. 2.
Oskar Schlemmer Delineation of *Space with Figure* (1927) and *Netz 2.0 at ACF London*

These different topologies can also mix in specific cases, such as the *Wintergatan - Marble Machine*[16] project by Martin Molins. Here, driven by a winding mechanism (circular topology), hundreds of marbles are set in motion, falling on sounding materials that are both arranged in ascending order (parallel topology) and freely arranged (non-symmetrical topology). Nevertheless, the concept of musical topologies might be used to categorise a large number of new instruments, NIMEs and other artistic strategies for sound creation, such as the project presented on the following pages. It helps to distinguish them from each other, which can take place at the level of interaction, as well as at the level of sound generation.

16. Wintergatan - Marble Machine: https://www.youtube.com/watch?v=IvUU8joBb1Q

2 THE NETZ 2.0 - A SITE-SPECIFIC INSTRUMENT

The *Netz 2.0* (see Fig. 2.) is a site-specific sound installation in the shape of a spider's web, which can be used as an instrument for sound generation by stretching its elastic strings. It is a musical instrument and an interactive sound installation at the same time. The visitor or musician can change and modify the structure of the net with physical force in order to create the various sounds. Developed in its first version in 2015 it received a major technical update in 2018. Following the previous thoughts on musical topologies and considering its physical arrangement and musical interaction, it represents a performative mesh topology.

2.1 Inspiration and Artistic Intention

The artistic inspiration for *Netz 2.0* as a musical instrument comes from different sources. It is influenced by modular synthesizers, that offer sound configuring using cable connectors. The resulting density of cables sometimes seems like a ‚network of sound streams'. Also, it is inspired by the *Theremin*[17] and its mode of operation, where the hands move freely and control volume and pitch by approaching two antennas. After all, it manifests parallels to playing drums, where physical interaction and physical exertion are the integral element of interaction. On an artistic level it is inspired by the geometric and performative space experiments of Oskar Schlemmer at the Bauhaus in Dessau, which he called *Mathematischen Tanz* or gestures dances (see Fig. 2.) (Goldberg 1988). Also the interactive dance and media performance *Apparition*[18] by Klaus Obermaier (Mocan 2013) had an influence. Obermaier's musical interweaving of space, movement and sound based on complex computer vision algorithms and a sophisticated set-up of projections also represents the use of space as an instrument. On the other hand, *Netz 2.0* is related to wildlife performances such as the spider's web, which is elastic, expansive and very resilient, especially regarding its geometry and thus is perfectly suited to catch prey.

17. Theremin: https://en.wikipedia.org/wiki/Theremin

18. Klaus Obermaier - Apparition: http://www.exile.at/apparition/

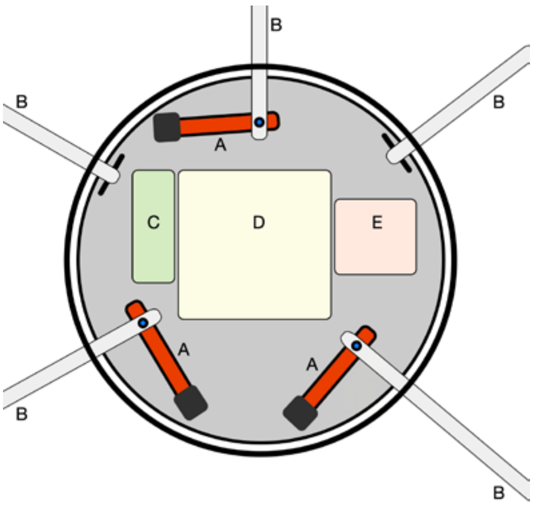

Fig. 3.
schematic: load cells (A), elastic strings (B), micro controller (C), powerbank (D), digital amplifier (E)

The combination of natural geometric forms and modern sensor technology addresses aspects of the ubiquitous use of technology. The *Netz 2.0* uses a mechanised environment as metaphor, becoming a kind of, environmental instrument'.

2.2 Force Sensing with elastic Rubber Tubes

On the technical side, the creation of a physical net structure that is elastic enough for interaction, but also capable of embedding available sensors and passing on their measures to a micro controller was challenging. Through tests with different materials the *Thera Band*[19] was identified as a suitable material.

Measuring the interaction with the material was more complex than expected. Based on design considerations, the data collection and processing should take place inside the center box, so the analog measurement signals had to be routed accordingly. In early tests conductive rubber cord stretch sensors[20] were inserted inside each rubber band to measure its strain resistance and read-out the user's interaction with the net, but the construction became very complex and fragile. The stretch sensors were quickly worn out and became unusable and the data acquisition was inconsistent and unreliable. Since the measurement of strain was not convincing, the next step was measuring the force applied to the individual strings of the net through force sensors, which consist of two components: the load cell[21] and the load cell amplifier[22]. The use of load cells has proven to be a suitable means of obtaining interaction data.

2.3 Software and Hardware Architecture

The following components are installed on the hardware level (see also Fig. 3.): main components are the load cells including load cell amplifier boards for force measurement. A *Teensy 3.2*[23] micro controller in addition with the *Teensy Audio Board*[24] and a Class-D audio amplifier board 2x15W including an external noise reduction filter between micro controller and audio amplifier are used. The audio gets played back from a waterproof loudspeaker 8Ω 20Watt. The power is provided by an USB LiPo Powerbank with 12V, 20.000 mAh, which has enough power to run the installation for two days. To power the micro controller a step-down converter is needed to convert the voltage from 12V to 5V. On the back of the box an On/Off switch is located as well as an USB socket to connect an external charging cable to the internal battery. The box is handmade of plywood and can only be opened by removing the loudspeaker. Attached to the box are 5 main strings of elastic tubes, each anchored in the wall and ceiling using hooks. Three of the five main strings provide force-measurement by sensors (see Fig. 3.). This decision is simply based on a lack of space within the central box, which left no space for additional sensors. The various elastic strings, that form the whole structure of the net, are attached to each other using

19. Thera Band: https://www.thera-bands.co.uk/

20. Conductive Rubber Cord Stretch Sensor: https://www.adafruit.com/product/519

21. Load Cell: https://www.sparkfun.com/products/13329

22. Load Cell Amplifier: https://www.sparkfun.com/products/13879

23. Teensy 3.2 USB development board: https://www.pjrc.com/store/teensy32.html

24. Audio Adaptor Board for Teensy 3.0 - 3.6: https://www.pjrc.com/store/teensy3_audio.html metal rings with double, shortened cable ties, allowing easy readjustment of the whole net structure.

On the software side the micro controller processes the measurement data delivered by the three load cell force sensors. When the device is switched on, the load cell amplifiers calibrate themselves to a zero value. The calculation of the values also includes the calculation of the negative values that occur when the load cells are not loaded through interaction, but relieved. Additionally, in the software the sensors are regularly recalibrated when inactive. Furthermore, the load cell amplifier offers two working modes, a slow but reliable mode with 10 SPS (samples per second) and a faster but less reliable mode with 80 SPS. The *Netz 2.0* operates with the faster mode of 80SPS for reasons of response time, low latency and playability. The sound generation is based on simple waveforms like Sinus or Sawtooth provided the the *Teensy Audio Library*[25] and prepared sound files are played back using the *Teensy Audio Board*. The waveforms are altered in frequency or pitch depending on the stretching of the assigned strings.

25. Teensy Audio Library: https://www.pjrc.com/teensy/td_libs_Audio.html

To summarise, the hardware and software configuration of the instrument is very robust and reliable. This is due to the few but reliable hardware components used, the stable technical construction and especially the separation between the strings as a medium of interaction and the speaker box in the center as enclosure for the sensitive electronic components and sensors.

2.4 Interaction Design and Composition

Interacting with the *Netz 2.0* takes place by stretching, pulling or otherwise tensioning the physical strings (see Fig. 4.). While the entire net can be manipulated, the inner segments are particularly reactive due to the arrangement of the sensors in the center box. The entire structure can also be shaken. While stretching, a considerable physical force has to be applied that makes playing a very physical interaction, which, however, is also very responsive and produces immediate sound output. On a musical level, the moments of slight phase shift are most interesting, in which the three different waveforms begin to oscillate together.

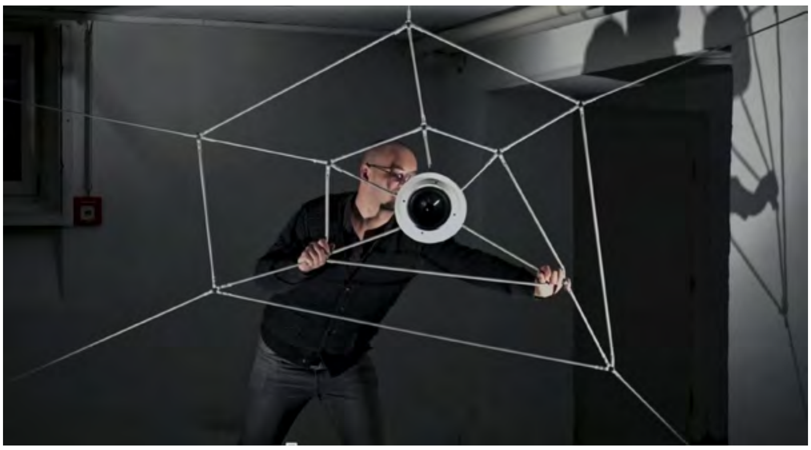

Fig. 4.
Netz 2.0 - video still
(https://jensvetter.de/netz-lab30)

2.5 Conclusion

The *Netz 2.0* has been shown at various festivals and exhibitions, including Ars Electronica, Kiblix Festival, Digital Design Week London and LAB30. It was demonstrated on stage during a talk at TEDx Linz. The audience feedback was very positive, emphasising the fun of playing it. Especially children loved to interact with it. In the future, an update to the sound programming is planned, as well as an implementation of data output using MIDI or OSC to interface with external instruments in order to incorporate the *Netz 2.0* into a larger instrument setup for stage performances.

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Collaborative artistic practices in a *Kaingáng* community as a dispositif for cultural development

Our paper offers an account of our experience with a collaborative art and technology project with the *Kaingáng* indigenous community of the village of Terra do Guarita, in the northwest region of the State of Rio Grande do Sul, Brazil. We present our reflections on the implementation of collaborative artistic practices looking to indigenous culture as context and not as theme. Our project bears witness as to how artistic practice conducted in a collaborative manner shapes and structures itself through the reality of the Other when art becomes a dispositif for social integration and cultural development based on an ethical-aesthetic paradigm. Based on artistic practices related to indigenous cultures, we set up audiovisual creation workshops and produced an affective mapping of the community with indigenous children, and subsequently, undertook the creation of a digital game for Android devices (in progress) based on *Kaingáng* culture and language.

Keywords
art and technology
collaboration
community
Kaingáng culture
DNA AKK.

1 INTRODUCTION

Collaborative artistic practices that work with communities have become increasingly prevalent in the field of contemporary art including art and technology. In 2018, ISEA Durban, the 24th edition of the International Symposium on Electronic Art, addressed the practices of art and creation of technology in reference to public and collaborative cultural practices of activist. This focus on collaborative approaches to creation can also be seen nowadays in journals, symposia, congresses and artistic events and are enthusiastically related to political, social and cultural local issues. From these initiatives, we can appreciate that artistic practices directed to specific localities and their needs are seeing an increase in development and public awareness (MALLMANN, 2018).

During the last decades, some artists have been performing an effective and affective art related to specific places and their individuals (LIPPARD, 2001). Collective and collaborative artistic practices emerge as part of the 60's and 70's art scene together with the actions of situationist, activist and feminist groups. However, it is during the 80's and 90's that a generation of emerging collectives in the arts intensify issues of collective authorship, collaborative agency and multiple interlocutors arising from shared, rather than singularised, expression given that the main focus of these artists's work was linked to the use of public spaces to site artistic gestures of a political nature (KESTER, 2011, p. 114). This allowed an important bridging of the traditions of conceptual art, public art and activism (KESTER, 2011, p. 112). Even if their productions varied greatly in purpose and proposals, Bishop maintains that artists of the 1990s willingly tied their work to social and political issues, dovetailing art to a social conscience. There was a widespread contemporary stance which saw in the creativity of collective action and in shared ideas a form of appropriation of power by artists as social empowerment (BISHOP, 2006).

The collaborative artistic practices reveal a set of common specificities, such as: effective exchanges with the community and/or specific groups, engagement with local social issues, intertwining with other areas of knowledge, and collective authorship. And importantly, in addition to being social processual propositions detached from a resultant aesthetic object, the relational interactive exchange becomes the creative praxis itself (KESTER, 2006). Over time, more and more methodologies have gained legitimacy which enable artists to work together in a variety of collaborative modalities and artistic projects—such as video collectives, maker labs, workshops, public meetings, group performance protests, etc—which a generation ago would have been offhandedly dismissed as community art (KESTER, 2011, p. 9). For Pablo Helguera[1] (2011), all art is social insofar as it is created to be communicated or experienced by others. However, to affirm that all art is social does not account for the distinction between an object, a painting, and a social interaction that is proclaimed as art, hence the denomination of "socially engaged art" (2011).

1. Mexican artist, critic and social activist engaged artistic practices.

These artistic projects that involve and evolve in collaboration with communities, require their own methodologies, since they are proposals that seek a direct relation with others' reality. In this sense, we can think of the contrast between ways of "doing art to" versus "doing art with" a specific community. Considering the difference between "to" and "with", the preposition "to" would refer to a patronising or judgmental attitude "to the local culture, forms of knowledge and social patterns". The preposition, "with", refers to the collaborative nature of art practices, as a "non-hierarchical and shared work" (KESTER, 2011).

In his discourse on the socialization of art in the context of Latin America, Néstor Canclini (1980, p. 31) refers to the term "art of liberation" as a way of proposing art that goes beyond a representation of its people and their political, social and cultural aspects. More than reproducing reality, he is interested in imagining the acts that overcome it, thus producing languages capable of participating in the transformations driven by society (CANCLINI, 1980, pp. 31-32). In this sense, it is necessary to understand art as an agent of transformation, as "a focus of creativity and social initiative", seeing art as a place for the possible (CANCLINI, 1980, pp. 32-33).

Currently, there are many artistic references to works that are conceived with communities, and specifically, we are interested in thinking about proposals in art that promote public awareness of ethnic groups and native peoples. These projects mainly aim to promote culture through creative actions in art as an act of political resistance. We can understand these proposals as being activist in nature—in which artists aim to include the community in the process—as a strategy to stimulate the awareness of the individuals and communities involved (FELSHIN, 2001). Lippard (2001) maintains that the recent emergence of interest in native cultures in the North American context is not only due to the production of art but due to the Indians' pride in surviving the colonization process and their indignation at the costs they have incurred for the detriment to their culture, health and land.

2 AFFECTIVE DNA: *KAMÊ* AND *KANHRU*

With the intention of approaching an artistic proposal that engages the community, we present the project "Affective DNA: *Kamê* and *Kanhru*" (DNA AKK), which was developed with an indigenous *Kaingáng* community in Southern Brazil. It is a proposal by Brazilian artist Kalinka Mallmann and an emerging *Kaingáng* historian Joceli Sales, their efforts being brought to bear through LabInter/UFSM. This artistic venture is based on actions that encourage active non-forgetting of the specific modes of social organization of the *Kaingáng* indigenous culture, activated by inventive and creative practices with children through art and technology.

Presently, there are *Kaingáng* people in the Brazilian states of Rio Grande do Sul, Santa Catarina, Paraná and south of São Paulo. It is estimated that a total population of approximately 34,000 *Kaingáng* are spread throughout various communities or Indigenous Territories (www.portalKaingang.org).

The project DNA AKK was conceived collectively through encounters and meetings between Kalinka Mallmann, Joceli Sales and the *Kaingáng* people of Terra do Guarita, located in the northwest part of the State of Rio Grande do Sul, Brazil which its 5,300 inhabitants makes it the third largest *Kaingáng* community in the country.

DNA AKK was the name suggested for the project because the project seeks to bring together 'genetic' material from multiple sources in order to create innovative sequences that would otherwise not exist: it encompasses the existence of a broad spectrum of connectivity among individuals within an inclusive system of transmission, of information, of collaboration. This concept also resonates with the purpose of the project to jointly create a connected and collaborative cartography of relationships, exchanges and affects within the community through marks which originate from cosmological geometries and not biological kinship (MALLMANN, 2018).

In this context, the handicrafts produced by the *Kaingáng* families is still one of the self-determined sources of subsistence for these communities. In the handicrafts, straw baskets stand out, and these illustrate the social divide between *Kamê* and *Kanhru*, through the differentiation of geometrical designs (open geometry for *Kamê* families, and closed geometry for *Kanhru* families) (Fig. 1).

Fig. 1.
Designs on straw baskets illustrate the social division between *Kamê* and *Kanhru*.

It was in the initial meetings, that the community was able to determine the overriding theme of the project as the use of the *Kamê* and *Kanhru* markings (Rá) which represent the inherent dualism of *Kaingáng* society. According to Jacodsen (2013), the dualism refers to a binary perception of the universe which reflects the presence and influence of the Sun and the Moon: the Sun principle is *Kamê*, whereas the Moon principle is *Kanhru*. *Kamê* expresses the symbolism of the Sun—warm colours, and a closed geometry; *Kanhru* expresses the symbolism of the Moon—cold colours and an open geometry. These binary cosmic distinctions are also reflected in their leadership system in terms of a social whole composed of two halves, of "opposites and complementaries". Thus, the *Kaingáng* are differentiated between themselves by the *Kamê* and *Kanhru* markings, which are portrayed principally on body paintings used in ceremonies, rituals, festivals, and especially in handicrafts (JACODSEN, 2013). Two parallel lines define the *Kamê*, and a filled circle defines the *Kanhru*s. These distinguishing marks are featured not only in body painting, but are also expressed through the geometry of handicrafts, and in their colours, among other applications.

In terms of kinship, marriage codes also subscribe to this understanding of the cosmos. For the *Kaingáng*, these marks are relevant in order to understand the cultural, social and cosmological conception of the *Kaingáng* people and how they relate to the world. When marriage is performed according to this conception, *Kamé* types should marry only *Kanhru* types and vice versa, and the children will receive only the paternal mark (JACODSEN, 2013); those with the same markings are brothers, and those with different markings are in-laws. The adoption of names and surnames was forced upon them by the Government's Fundação Nacional do Índio (Funai) agency in order to be able to acquire official documentation or to register property, since notaries did not accept *Kaingáng* lineages. Many saw this as abject colonisation and subjection and as destruction of their heritage, history and kinship lineages.

The population of the Guarita Indigenous Territory has long suffered the process of white man's colonisation, and the practice of *kamê* and *kanhru* markings ended up being almost extinguished by the use of names and surnames imposed by the institutions of the white man. The empowerment implied by the use of the renewed use of the markings in the *Kaingáng* community is enormous as this becomes a recognition of a *Kaingáng* past and an affirmation of their history as the basis for social organisation. In addition, the practice has bolstered a sense of identity and belonging, as well as cultural perduration amidst the pressure for assimilation by mainstream Brazilian culture. The Guarita Territory is surrounded by urban development, so direct contact with these citified environments has been changing the cultural customs and traditions of the *Kaingáng* communities who are struggling to maintain "their way of life" despite of this constantly increasing external pressure.

To widen interest in the project and to raise awareness for the work being carried out, several initiatives were realised. In November 2016, an animation/installation was presented at the exhibition "Art, Topology, Technology—LabInter 2016", at the Carriconde Gallery in UFSM, Brazil. The public exhibit presented a conceptual record of the project itself, which networked itself outwards into other artistic proposals and creative gatherings, most markedly through social media.

In July 2017, the first audiovisual creation lab workshop took place at the "EEIEF Gormecindo Jete Tenh Ribeiro" public school with the production of digital drawings (Fig.2). The activity focused on the children's encounter with the *Kamê* and *Kanhru* signs and their symbolic significance within daily life and culture in the village.

Fig. 2.
A *Kaingáng* child producing a digital drawing

In a second meeting, Joceli Sales and the children walked around the community, taking photographs and shooting videos with tablets (Fig. 3). These actions incorporated the participation of the children, the parents, the elderly of the community in order to heighten subjective assurance and mediatic empowerment, familiarise the community with digital technology, and produce testimonials which would give sense and definition to what it means to be *kamê* or *kanhru* within the *Kaingáng* indigenous community.

Fig. 3.
Kaingáng children taking photographs and making videos.

This action is developed with the children as an expanded reality which incorporates simultaneous temporalities and spacialities within the community by populating it with interviews of relatives, photographs, videos, and oral histories as digital narratives adapted to their aesthetic vision. Following the suggestions of Grant Kester (2011), the carrying out of the project with the *Kaingáng* in the indigenous territory becomes a performative artistic gesture in itself where meetings, audiovisual workshop creation, participating in community events, conversation with the members of the community, etc become important means of creative facilitation within collaborative art projects in communities.

The children, together with the teachers of the school, Joceli Sales and some members of the LabInter, were divided into groups and given the mission to interview each village resident and indicating in a map the *Kamê* and the *Kanhru* families. Thus, an analogue map (Figure 4) was constructed, with annotations made by the students, in which it was possible to visualize the prevalence of *Kanhru* families in the village. However, the major objective was to enable these children to recognize themselves in a "*Kaingáng way*", in which kinship is defined cosmologically.

Fig. 4.
Children of the village of Terra do Guarita participating in the elaboration of an analogue map.

3 DNA AKK DIGITAL GAME

After these actions with the indigenous children, and having established relations of trust and respect, we began discussions with the community towards the possibility of creating a digital game for Android specifically for the *Kaingáng* people based on Kamê and *Kanhru* lore. In November 2018, through meetings, lectures and audiovisual workshops, the children of the village collaborated with the artist/developers from LabInter in the construction of a game for Android. The children fully integrated in the creative effort by drawing the characters, some animals and food, as well as illustrating the activities they performed, such as fishing and hunting. The students were attentively listened to, and these materials (drawings and notes) served as support for the team at LabInter who developed the game, who participated in all the community actions in the village. It is important to note that the association between the LabInter team and the *Kaingáng* children generated an aura of mutual affection and respect. From this perspective, we suggest that in collaborative art projects not only are the tasks and stages of a given action shared, but in a more significant way, subjectivities are inter-linked: there is a process of affective interactivity that emerges as a growth in the capacity to affect and be affected that happens amidst the sense of solidarity and empathy.

The creation of the game is an on-going endeavour. We are using Unity as the real-time engine behind the development of 2D and 3D graphics, where the chosen format being 3D, as the main method of realization. In addition, as an auxiliary methodology within the 3-D environments, we are using Blender as a modelling software. Together with Unity, Visual Studio software was used for programming the game in the object-oriented language, C#. The focus of the game's design has the children as its main public and banks on the portability and ubiquity of mobile phones. At the end of the project an optimization will be carried out so the game can run smoothly on a wide range of devices.

The game is based on the *Kaingáng* culture through mechanics that refer to the language and culture. In the initial menu, the player has access to one of the biggest forms of personal identification where he/she can choose between being "*Kamê*" or "*Kanhru*" or being "day" or "night". This choice has the purpose of locating the game in the cultural environment, generating significant impacts on the development of the game, the scripting of the scenario, the main character design and the visual interface using colours corresponding to each of the cultural marks.

The main objective is to communicate *Kaingáng* culture to the users. The game has been fully developed in the *Kaingáng* language— the menus, the mini-games and the dialogues of the characters appear in graphic form or are spoken in the *Kaingáng* language. Additionally, special attention was given to integrating their cultural personages and mythological characters. For example, in some *Kaingáng* tales there are animals that speak, and these can be found throughout the game seeking to teach the players the aboriginal language through writing that will be displayed on the screen and audio recordings that will be played when the player approaches the animals. There will also be pedagogic mini-games to encourage the players to assimilate the language and render the learning experience more dynamic. And because the teachers of the local public school were also involved in the project, some of the project's practices will be incorporated into the curriculum.

The game's narrative is built around missions that the players must complete in order to unlock new territories. In the course of playing the game, a player encounters various cultural aspects on the map, thus also facilitating indirect learning. In keeping with the *Kaingáng* culture of the community, the figure of the cacique, or tribal chief, appears as a role model character who fosters strong social bonds and indicates the course of the game. He appears on the screen at key moments, indicating to the player how to proceed. Other *Kaingáng* personages populate the experience to create a fuller cultural environment for the game.

Among the *Kaingáng*s, there is a prescriptive tradition of marrying *Kamé* with *Kanhru*. Aiming at this set of beliefs, the ultimate goal of the game is to find one's partner and make an alliance following the ancestral cultural customs. In this way, the game produces a strong motivation for completion expressing conciliation between *Kamé* and *Kanhru*. To guarantee this involvement, is important that the players feel that the game represents them and that it was made for them. The journey begins in the tribe chosen by the player in the initial menu and unfolds through exploratory missions toward the expansion of territory as determining the player's specific journey in quest of an alliance. The play action throughout the game has been optimized to ensure easy navigation by players of all ages and to further pursue the interaction between *Kamé* and *Kanhru*, a multiplayer mode will be added to the game, requiring cooperation and interaction between both parties.

Fig. 5.
A frame from the DNA AKK game showing the *Kaingáng* village play environment.

Kaingáng indigenous culture is the motivating drive and guiding element in the DNA AKK project in terms of designing proposals that directly speak to *Kaingáng* social binarism and its respective marks. In this way, the *Kaingáng* culture ceases to be artistic theme and content and instead becomes context and experience so that any aesthetic outcome from collaborative practices is a consequence of the experience of shared doings.

In all the activities of the DNA AKK project, the focus was on the shared doing and not on individual propositions. The project proposals that were developed originate from collaborative undertakings which arise from discussion between the community and artist and the *Kaingáng* historian Joceli Sales, who also assumes the role of mediator with the *Kaingáng* community and carries out liaison duties. As the project reaches conclusion, the drive towards autonomy requires greater involvement from the participants and a feeling of trust from the community as all parties move towards the final hand-off.

Opening up *Kaingáng* indigenous culture to its preservation is the main intention motivating and guiding the activities in the DNA AKK project. The collaborative artistic practices that informed our activities look to foment indigenous subjectivity by enabling the *Kaingáng* people to be the narrators of their own history and their own stories. Within these practices, the artist-researcher becomes a facilitator whose creative task is to activate potentials and safeguard subjectivity in the midst of today's globalisation processes, such as online networks and social media. Understanding the project as a collaborative and affective system that goes beyond the limitations of traditional social art projects, we see how digital art and technology can foment subjective empowerment and potentialise human relations. Collaborative modes in art mean provide that any aesthetic result is nothing more than a consequence of the experience of shared endeavours.

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serraE: Re-Visioning the Chinese Yu as Mechatronic Musical Instrument towards Revitalization and Preservation

Keywords
mechatronic musical instruments
ancient musical devices
new interfaces for musical expression
music archaeology

The *yu* is an ancient Chinese scraper-class percussion, used to indicate time (specifically, the end of a piece of music) in court and ritual music. The *yu* was played by scraping across 27 serrates and striking the body of the percussion, using a bamboo brush mallet. Although the *yu* had limited musical function, it was included in court and ritual ensembles due to its unique design and distinct playing schema. Despite its cultural significance, the *yu* is not used today and is only seen in museums. This paper describes an approach to re-vision the *yu* towards revitalization and preservation through its reconstruction as a mechatronic musical instrument.

1 INTRODUCTION

Musical instruments and traditions are important because they inform the development of music technology, creative processes, and musical interaction modalities (Tanaka 2009). As such, their preservation is important because they are culturally significant and contribute to the body of knowledge about our past and are great inspirations for what can be possible with technology. Ancient musical instruments are usually exhibited in museums and this is only possible if such artefacts are excavated. In other cases, we would learn about these instruments through representations of musical scenes and textual evidence in literary works. As such, even when the ancient musical instruments are available, the engagement with them remain rather limited, contributing to the decline of their knowledge and inheritance.

In recent years, the use of new musical interfaces in preserving and revitalizing musical instruments and heritages has increased. Serafin and Gotzen reconstructed Russolo's intonarumori as digital musical instruments with sensors, microcontrollers, and computer-based sound synthesis engine (Serafin and De Götzen 2009). Their enactive approach focuses on gestural interaction to illustrate and enhance the playability of the lost twentieth-century musical instrument towards preserving and revitalizing the intonarumori. Aaron Kuffner's *Gamelatron* creates sound-producing kinetic sculpture by augmenting traditional Balinese and Javanese gamelan instruments with motors, allowing them to be controlled via Musical Instrument Digital Interface (MIDI). This enables uncommon or lost gamelan traditions to be presented in new contexts, contributing to its revitalization and outreach (Kuffner 2008). Through a series of works that augment North Indian musical instruments with sensors and developing North Indian music inspired mechatronic musical instruments, Kapur's approach towards preservation focuses on sustaining the developments of music traditions by integrating new technologies (Kapur 2008). The use of these new musical interfaces in new performance scenarios and contexts, such as the Machine Orchestra, also contributes to the revitalization and outreach of North Indian classical music. While the use of new musical interfaces in preserving and revitalizing musical instruments and traditions are not new per se (a comprehensive survey of prior works can be found in (Kapur 2008; Hochenbaum 2013; He et al.,)), there has yet to be works that reconstruct ancient musical instruments as new mechatronic musical instruments, specifically the reconstruction of ancient Chinese musical instruments.

Inspired by ancient Chinese sound worlds, this work builds upon prior research to combine methodologies in music archaeology and new interfaces for musical expression to re-vision the ancient Chinese *yu* percussion. Through its reconstruction as a mechatronic musical instrument (MMI) and re-contextualizing its application beyond traditional contexts, it is hope that this work will contribute towards the outreach, revitalization, and preservation of ancient musical devices by sustaining their development and enhancing their playability in today's context.

To this end, this paper presents the modern re-visioning of *yu* as serraE, an ensemble of mechatronic scraper-class percussions. Section 2 introduces yu, providing a background overview and its cultural significance. With an understanding of the ancient Chinese scraper-class percussion, Section 3 describes the design approach towards its re-visioning as a mechatronic musical instrument, and presents its system overview and applications in mechatronic sound art performances. Finally, the paper concludes with a discussion of the work presented and future works.

2 BACKGROUND

The *yu* is an ancient Chinese scraper-class percussion with a long history, recorded amongst 105 ancient musical instruments in historical literature such as *Shi Jing* (Classic of Poetry) and *Shang Shu* (Book of Documents). The musical function of the *yu* was to indicate time, specifically to mark the end of a piece of music, in *Ya Yue* (Chinese classical music and dance performed at royal court) and *Li Ji* (*ritual music*). Despite its limited musical functionality, the *yu* was included in the royal court and ritual ensembles due to its unique construction and distinct playing schema. The *yu* is not used and made today, and is most often found in historical museums, such as the *Gu Gong*.

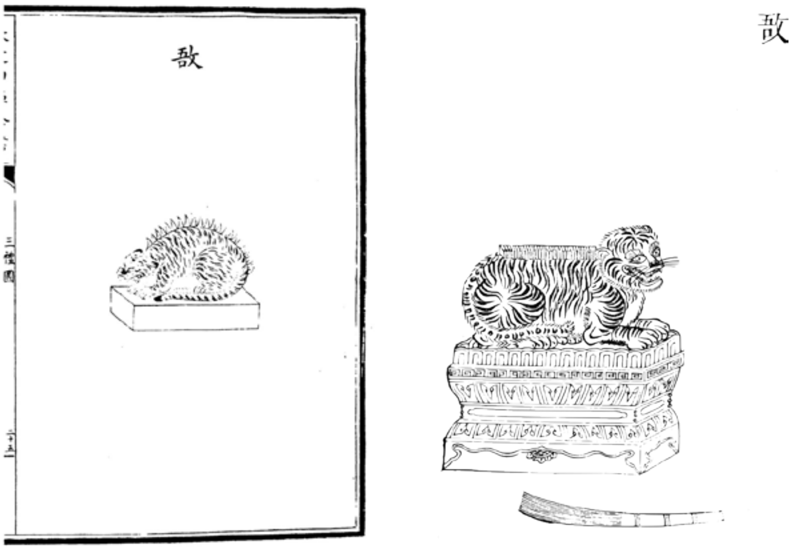

Fig. 1.
Illustrations of *yu* from historical literature (left) *San Li Tu* (Nie 1673)and (right) *Gu Jin Tu Shu Ji Cheng*, also known as the Imperial Encyclopaedia (Chen 1726).

While the Esteemed Documents and Book of Documents provided information on musical instruments and their functions, later literary works, such as Song dynasty's *San Li Tu* and Tang dynasty's *Jiu Tang Shu Yin Yue Zhi*, depicted variations in the structure of *yu* (as illustrated in Fig. 1.), the materials used for its construction, and playing schema during different time periods. This informed the non-prescriptive re-visioning approach of the *yu* as serraE in its design and reconstruction, which will be described in Section 3. While there were variations in materials, form, and playing schema, three characteristics remain consistent: structure, sound-producing mechanism and musical function.

Fig. 2.
Yu from the Beijing Gu Gong Museum's collection of ancient musical instruments (Zhao 2009).

Structurally, the yu is shaped into the silhouette of a tiger resting on a pedestal (as shown in Fig. 2.). On its back, there are 27 square serrates. The *yu* is played with a bamboo brush (similar to a multi-rod drum stick) that is made up of 10 fine bamboo dowels. As recorded in historical literature, the performer stands adjacent to the *yu* and plays the instrument via two gestures using the bamboo whisk — 1) striking the body of the percussion, and 2) scraping across the serrates. The combination of typically three strikes and one scrape in succession forms the musical gestalt used to mark the end of a piece of music. While the combination of strikes and scrapes remained consistent, their order and count varied. Sonically, the characteristic of tones produced by the *yu* is not prominent and not distinctive.

With an understanding of the *yu's* structure, form, and its sound-producing mechanisms, the following section describes the re-visioning of *yu* through its reconstruction as a mechatronic musical instrument.

3. *serraE*

serraE (as seen in Fig. 3.) is an ensemble of mechatronic scraper-class percussions, which is a modern re-visioning of the traditional Chinese *yu*. *serraE* consists of four units of *serra* and a microcontroller that controls scraping and so-

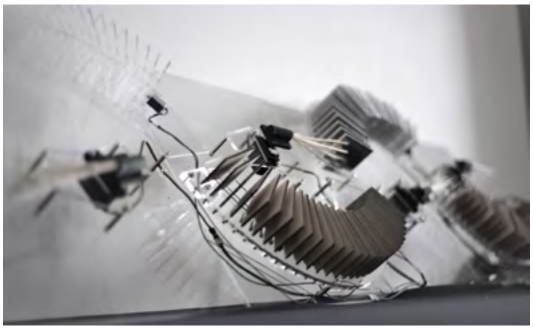

Fig. 3.
serraE: An ensemble of mechatronic scraper-class percussions.

3.1 Design Overview

The overall design of *serraE* takes a minimalist approach towards its design, form, and structure (as illustrated in Fig. 4). *serraE* also utilizes repetition and iteration, resulting in 4 units of *serra* with variations in the materials used for each group of serrates. This is a common feature in contemporary mechatronic sound art and representative of today's practice (Zareei et al. 2014).

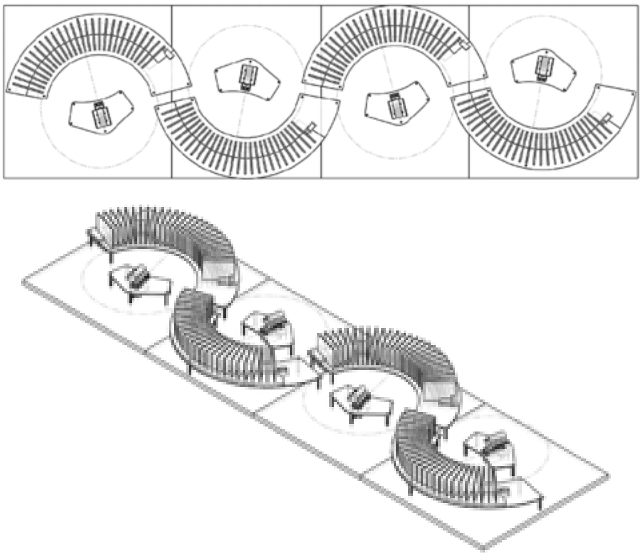

Fig. 4.
sketch of *serraE* with 4 units of serra repetition and iteration in top view (top) and isometric view (bottom).

serra is mainly constructed of acrylic. The variations in *yu's* construction materials over the different time periods in historical literature motivated the choice of materials used for the serrates of each *serra* unit — acrylic, cardboard, wood, and steel (as shown in Fig. 5). As synthetic polymers are some of the most common materials today, Acrylonitrile butadiene styrene (ABS) is used to create the dowels for the four scrapers. Furthermore, the different materials, when struck and scraped, result in a variety of timbres. This extends the characteristic of tones produced, and enhances the non-distinctive tones of the ancient *yu*.

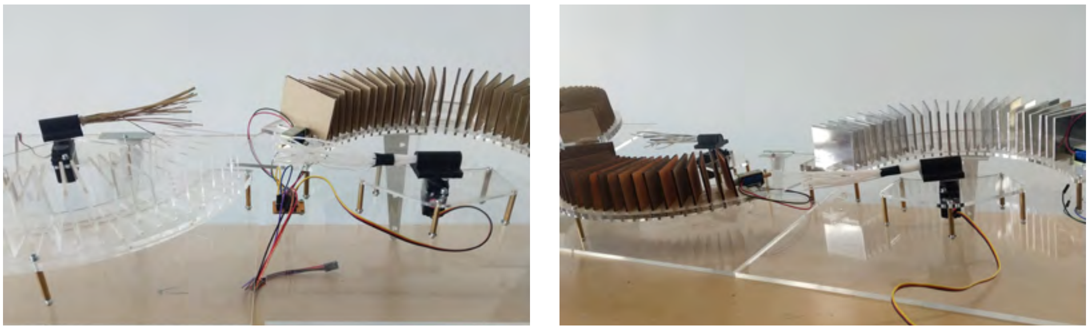

Fig. 5.
Four units of *serra* fitted with serrates of different materials.

3.2 *serra*

Each *serra* unit consists of 27 serrates, one solenoid, one servo, and a scraping apparatus. The sound-producing mechanisms of *yu* is mechanized through a solenoid to strike the surface of a serrate, and a servo to scrap the 27 serrates. These emulate the sound-producing mechanisms of the ancient *yu* percussion. The bamboo brush of the *yu* is reconstructed with the combination of a custom 3d-printed holder that attaches to a X servo horn, and 10 fine dowels of ABS filament as illustrated in Fig. 6.

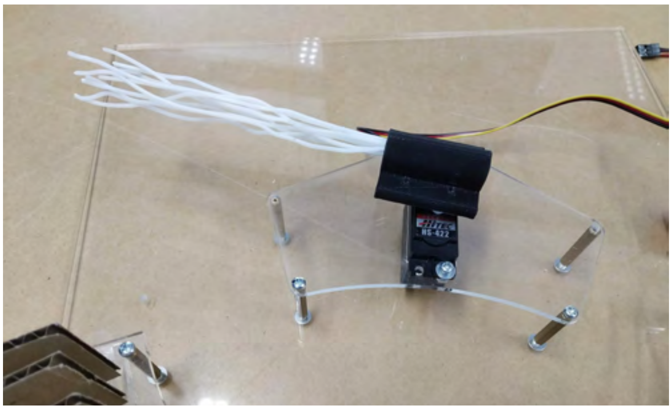

Fig. 6.
Scraping apparatus made of 10 fine dowels, made of ABS filament.

3.3 System overview

Fig. 7 illustrates the system diagram of *serraE* and its data flow. Each *serra* has a custom PCB that houses the electronic circuits for driving a solenoid and a servo motor. Each unit of *serra* then connects, via 2x3 connectors, to the main *serraE* PCB. The main PCB comprises of a Teensy 3.6 microcontroller (flashed as a USB-MIDI device) and a 5V step-down voltage regulator circuit. serraE connects to the laptop via USB and is controlled via MIDI.

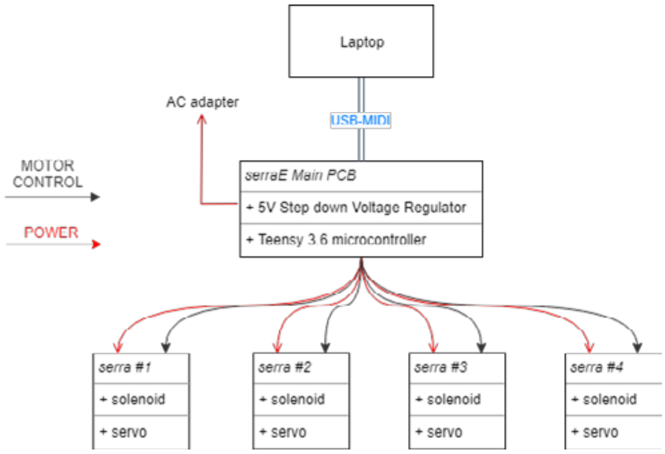

Fig. 7.
System diagram of *serraE*.

MIDI messages from the computer is interpreted, by the microcontroller, to appropriate motor instructions that are sent to each serra unit. Table 1 provides an overview of the control interaction scheme employed by *serraE* to parameterize MIDI messages to actuating the servos and solenoids of each *serra* unit.

Sound-producing Mechanism	**Dimensionality of Control**	**Physical Attribute**	**Control Modality**	**MIDI Type**
Solenoid - strike	2 dimensions	On/ off	discrete	Note On/ off
		Strength of strike	Quantized continuous	Note Velocity
Servo - scrape	2 dimensions	On/ off	Discrete	Note On/ off
		Speed of scrape	Quantized continuous	Note Velocity

Table. 1.
An overview of *serra's* control interaction

3.4 Application in Performances

serraE was used in two major occasions — *serrate study no. 1* at Si17 Soundislands Festival 2017 in Singapore, and *knowing one's sound* at the 2017 International Computer Music Conference in 2017. The pieces explore *serraE's* musical functions through two performance scenarios. Furthermore, they enable the outreach of *yu* to communities that are unlikely to engage with it.

serrate study no. 1

In *serrate study no. 1*, presented at Si17, the approach to play *serraE* is via an instrument-performer relationship, where spatial and temporal information transfer from human to instrument through dynamic encoding in body movements (Pressing 1990). As seen in Fig. 8, a custom hand gestural controller and a grid controller were used to control *serraE*.

Fig. 8.
Excerpt of previous performance at Si17 Soundislands Festival 2017, Singapore. (https://vimeo.com/310240604)

The strike mechanism is activated when there is high jerk in the vertical axis, while the scraping mechanism is activated when high jerk is present in the horizontal axis. The magnitude of jerk is then parameterized as either the strength of strike, or the speed of scrape. To enable the independent control of each mechanism among four units of serra, the grid controller is used as a switch to enable/ disable the effects of the instrumentalist's motions. This strategy allows *serraE* to be played as a traditional musical instrument, affording a good range of tones (inherent from the different materials used), dynamic control and freedom to lock in/out of metric-rigidity for the instrumentalist.

knowing one's sound

knowing one's sound is a human-mecha performance that features a human guqin instrumentalist, *serraE*, and *Swivel*, a highly parametric mechatronic chordophone. In this piece, the interaction between the mechatronic instruments and the human performer is mediated by the modalities of custom interfaces and abstract mapping schemes to render imagery of sonic and movement choreography. Both *Swivel* and *serraE* are programmed to perform with agency and autonomy, reacting to the physical hand gestures of the guqin instrumentalist as seen in Fig. 9.

Fig. 9.
Excerpt from performance at the International Computer Music Conference 2017, Shanghai. (https://vimeo.com/317641742)

4 CONCLUSION

In this paper, the ancient Chinese scraper-class percussion, *yu* was introduced. With an understanding of its background, significance, and its 'lost' status, this paper presents the approach of re-visioning the *yu* as a mechatronic musical instrument. Following the description of its design and system overview, *serraE's* application in two contrasting performance scenarios is presented. The re-visioning of *yu* not only brings the ancient scraper-class percussion to live, but also enables further engagement, continued development and utilization in new contexts.

With the modern re-visioning of the *yu* as a mechatronic musical instrument, the ancient instrument revitalizes with an extended range of tones due to the use of different materials and actuating mechanisms that can operate beyond the limitations of a human body. The mechatronic movements further emphasize the unique playing schema and sound-producing mechanisms. These further enhances the aesthetics that the ancient *yu* percussion embodies.

From a cultural heritage perspective, the preservation of ancient musical instruments is important. Nowadays, few can describe what *yu* is, not to mention its design, sound producing mechanisms and musical function. This further reveals the importance of inheritance. Since the few original instruments are only displayed in museums and the instrument tradition 'lost', it is important to revitalize this unique ancient musical device of ancient Chinese musical heritage. It is hope that *serraE* will encourage further reconstructions of other ancient musical devices.

Future works will include the development of *serraE* towards an interactive installation, that accompanies its excavated original artefact. This will provide additional engagement and dimensionality to the *yu* in the displays of museums. With the success of the first reconstruction, it is hope that the presented approach of re-visioning as mechatronic musical instruments can be extended to other ancient Chinese musical devices, as well as ancient devices of other musical traditions.

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Modalities of Improvisation in Live Coding

Keywords
live coding
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Live coding is a practice of computer programming used to create music and digital media that strongly relies on improvisation. While live coding, as a relevant form of contemporary artistic practice, is a lucrative research topic, improvisation in this interdisciplinary setting is scarcely systematically explored. This paper investigates modalities of improvisation and its relation to composition in live coding from multiple viewpoints. First, we provide an overview of improvisation in its historic and contemporary contexts identifying common traits of traditional, live electronics, and computer-aided improvisation. Then, we discuss and categorise modalities specific to live coding based on the nature of pre-written code and the types of real time interventions. Besides theoretical views, we present a case study – our practical experience with one of the improvisational modalities used to create music for a contemporary choreography.

1 INTRODUCTION

The relationship between improvisation and composition in the context of music has been a long and strenuous one. Especially when Western music traditions are concerned, composition was often ascribed characteristics that elevated the approach and methodologically elaborate techniques above all else (Larson 2005). Improvisation was, in contrast, seen as a thing of itself, an “irrational” and unstructured form of expression. Similarly, while improvisation in music can be traced back to traditions dating before the medieval period and even if composers like Mozart and Beethoven used variations extensively, in academic texts it was frequently shunned, ignored, and held to lower standards. It was considered a parlour trick that sat on the opposite side of the semiotic perfection and purposefulness of composed music (Nettl 2013). These academics will often resort to Platonic philosophy, demeaning the sensuous and undisciplined (improvisation) in favour of the rational and the controlled (composition).

That stance changed considerably in the latter part of the twentieth century as contemporary composers began incorporating improvisation in the core of their work (MacDonald et al. 2012) and developed techniques and approaches like aleatory music (Hoogerwerf 1976). Simultaneously, popular jazz idioms slowly but surely made their way into the hermetic spheres of academia via cultural appropriation (Born and Hesmondhalgh 2000). Recently, improvisation and composition have become viewed by researchers as deeply connected members of a continuum and correlative relationship instead of two sides in conflict (Nettl 1974). In that sense, improvisation becomes a precondition for all composition processes (Wilson and MacDonald 2017).

Outside of the Western sphere, improvisation was and remains an important part of religious and transcendental rituals (Hodgkinson 2016, Houseman and Severi 1998). For practitioners of improvisation in the fundamental sense, these processes come naturally, without primary aesthetic or artistic consideration. Still, they produce valuable artistic and highly aesthetic results.

Today, improvisation can be heard in various musical styles and is often meshed with composition. Outside of particular genres like free jazz and free improvisation, which both hold improvisation at the core of their creative processes, it is also a relevant factor in certain styles of electronic music, pop, rap, etc.

In the field of electronic music, one type of creative practices especially relies on improvisation: live coding. The art of using computer programming, algorithms, and code as makeshift scores and music creation tools is built around improvisation, with musicians most often writing code in real time during live performances. While live coding is a productive and rich field of research – with researchers considering both technical and artistic implications of the practice – the continuum of improvisation and composition within it is scarcely explored.

The focal point of this paper is on modes of improvisation in live coding. A case study based on a real life live coding experience is presented, delineating the influences of improvisation, composition, and their amalgamations in the interdisciplinary setting of live coding. To support our analysis, we first explore different aspects and characteristics of improvisation, providing a brief overview of the relationship between improvisation and composition. Both historical and contemporary implications are considered, but with a focus on the latter. We also present existing studies in the field of live coding that might indicate the position of improvisation as well as stylistic limitations related to technologies and well-known improvisation and composition techniques.

Finally, we outline future work that, based on the premises presented in this paper, will seek to challenge (mis)conceptions about improvisation in live coding and, more importantly, will try to employ human-computer interfaces and modified live coding environments to improve the improvising experience.

2 A CASE FOR IMPROVISATION

2.1 A Brief History and Ontology

In his book Music and the Myth of Wholeness (Hodgkinson 2016), experimental music composer and performer Tim Hodgkinson notes:

> Perhaps this is the moment for a hymn to improvisation, first, because an improvised action cannot, by definition, be repeated. Improvisation directly attacks the formula what is must be, and says instead, what is ... could have been otherwise ... and certainly will be otherwise. Second, improvisation is against plans and automatisms. We see distinctive traces of indeterminacy throughout the spectrum of artistic production in self-consciously historical societies. The generative importance of the improvisational and the accidental enters everywhere, even when not explicitly presented as such. In our own culture this becomes explicit as artistic method in the early twentieth century.

For Hodgkinson, improvisation is at the heart of all creativity in music, be it in evidently improvised or composed contexts. He attributes almost transcendental characteristics to improvisation, which he frames into a theory of the “aesthetic listening subject”. Indigenous cultures, like the Tuvan tribes in Siberia, he argues, employ improvisational practices in their everyday rituals. Their purpose is healing and not art. That is to say, for Hodgkinson, improvisation is a part of the human experience regardless whether it is intentional or not. Yet, it was only during the beginning of the twentieth century, spurred on by expressionist art and Dadaism, that the practice became self-aware and codified into “free music”.

Apart from Hodgkinson who presents a comprehensive overview of improvisation and considers its philosophical, religious, and musicological implications, notable researches and resources on the subject are (Nettl 1974), (Chase 1988), and (Benson 2003). While these texts differ in the approach and classification of improvisation, they reach similar conclusions.

Historically speaking, the actual emergence of a freely and collectively improvised music is indebted to African-American music and its development in specific geographical and stylistic loci like New Orleans, bebop, etc. These developments coincided with rising interest in indeterminacy, open form, and aleatory techniques in European composed music. This ultimately separated free improvisation from the jazz idiom as part of which it had developed as a practice.

2.2 Contemporary Practices

Contemporary free improvisation can be, almost ironically, considered a genre with specific tropes, idioms, and constraints that is ultimately ruled by a certain stylistic determinism. As we will show in later chapters, there is evidence that this might not be a coincidence and instead a potential common trait shared between improvisation-based practices (e.g. live coding). In fact, John Cage's most notable critique of improvisation (Feisst 2009) is that there is no true (collective) improvisation and that musicians will undoubtedly always find themselves in routines and repeated patterns. In other words, improvisation will always generate its own antithesis.

But it is exactly this aspect of improvisation that connects it to composition. In that sense, we can say that improvisation can both be viewed as spontaneous composition and, when distilled to its core processes, a part of each compositional approach (Sawyer 1999). Continuous and repeated improvisation can become ingrained, classified, and formalized. Or, if we reverse the flow of information, we can consider composition to be built on top of quiet, non-performative improvisations in the mind of the composer.

In the context of contemporary free jazz and improvisation, we can identify three types of approach to improvisation and composition. First is the "classic" approach characteristic of post-bop and similar styles closely connected to traditional forms of jazz. Here, most music is composed, with well-known techniques used repeatedly and extensively. A common style can usually be identified. Improvisation is pushed to solo sections and phrasing variations, but all within a well-defined and static framework. Additionally, the improvisations themselves usually follow a certain set of patterns (Martin 1996).

The second approach can be found in contemporary free jazz, championed by the likes of Chicagoan Ken Vandermark, an often used approach is to employed precomposed themes and sections which the musicians then evolve and improvise against during live performances. These themes can serve as starting points for collective improvisations, meaning that while certain harmonic, rhythmic, and melodic characteristics will be shared between performances, the structure, overall tone, and final form of the compositions will vary greatly. While based on a different set of concepts, we can include techniques like John Zorn's game pieces (Van der Schyff 2013) or some of Anthony Braxton's concepts in this category as they lay out very specific theoretical music frameworks that then serve as basis for improvisations.

Finally, the third approach is rendered through true free improvisation or completely spontaneously created music. These performances should, ideally, be completely unique and can be the result of the first meeting of musicians. There are no pre-imposed themes or rules and instead the performance relies on the shared musical connection between performers and their ephemeral interactions. Practice shows that, because the musicians are rarely blank slates, even free improvisation in the fullest sense can become ruled by the musicians' previous experiences, shared performances, etc. Many musicians note how difficult it can become not to repeat previous phrases and interactions during repeated performances with the same opposite players (Hallam et al. 2011).

As we will note in the third chapter, these three concepts can also be applied to live coding. Additionally, while an interesting subject, the implications of recorded improvisations will not be discussed in this paper.

3 THE NATURE OF IMPROVISATION IN LIVE CODING

The origins of improvisation in live coding are, in conceptual and poietic terms, related and akin to the development of live electronics. In his paper Gentle Fire: An Early Approach to Live Electronic Music (Davies 2001), Hugh Davies traces the history of live electronics through the experiences of his group Gentle Fire, dating back to the 1960s. He outlines the basic processes and motivations behind the music and explores how the semantics and practices revolving around live electronic music evolved. Many of these thoughts and concepts can be applied to live coding.

Throughout, Davies underlines the importance of improvisation or spontaneous performative actions that influence the music and compositions. Additionally, the importance of Davies's work is extended to traditional improvisation as he was a part of The Music Improvisation Company in which he collaborated with leading free improvisation musician and proponent Derek Bailey. The group's focus was on meshing live electronics improvisation with existing free improvisation techniques. His work, along with the work of luminaries like John Chowning (Zattra 2007) and Peter Zinovieff (Risset 2007) are the earliest examples of improvisation being featured as part of the live performance of electronic music. In that sense, we can see these and similar related works as precursors of live coding.

On the other side of the spectrum, and contrasted to today's notion of "laptop music" which carries mainly negative connotations related to the phenomenon of music prepared in advance and only reproduced in a live environment on stage (Cascone 2002), some of the earliest attempts of using computers for improvised music can be traced to practices related to "laptop ensembles". Laptop groups like The Hub and EMU ensemble, both dating to the 1980s, used laptops to create collective improvisations (Knotts and Collins 2014).

The origins of live coding, in a narrower sense and as we understand it today, can be traced to the early 2000s and works such as (Collins et al. 2003). In this seminal research, improvisation is considered to be an integral part of live coding from its onset. When looking at recent developments, notable is the work of Thor Magnusson who argues for live coding and algorithms as extensions of the musical score (Magnusson 2011). Here, improvisation becomes imbued in the musical score and the lines between improvisation and composition are blurred. For Magnusson, improvisation in live coding is the equivalent of real-time composition:

> Live coding is the offspring of the two strong traditions described above: the formalization and encoding of music, often for machine realization, on the one hand, and the open work resisting traditional forms of encoding on the other. Live coding is a form of musical performance that involves the real-time composition of music by means of writing code.

Elsewhere, researches such as (Freeman and Van Troyer 2011; Wilson et al. 2014) all view live coding as primarily an improvisational technique or a fusion of both improvisation and composition. These researches serve as evidence of notions presented in the previous chapter: improvisation and composition are ingrained and interdependent. As will be explored in the following chapter, live coding can combine several degrees of composition and improvisation techniques, but is ultimately reliant on improvisation during live performances.

While it is primarily viewed as a technique with the potential to influence live performances and change dynamics attributed to mainstream electronic performances deemed to be otherwise static – musicians just pressing "play" – live coding must also be viewed through the prism of influencing and shaping the creative processes of musicians (Magnusson 2014). In this sense, it is interesting to consider whether live coding imposes its own set of preconceptions and stylistic trademarks similarly to what can be observed in traditional free improvisation or whether it can, through various mechanisms, free the performers from exactly these learned and repeated behaviours.

3.1 Improvisation Practices in Live Coding

Analogous to the contemporary practices in free jazz, free improvisation, and similar genres, we can say that improvisation appears in three forms in live coding, depending on the level on which improvisation occurs.

The purest type of improvisation in live coding is when code is written from scratch during live performances. In this case, the musician or coder forgoes any preparations and relies solely on spontaneous ideas and thoughts. This modality of improvising coincides with the processes in traditional free improvisation. Obviously, just like in the case of free improv, the musician is influenced by previously written code, which they can recollect, earlier experiences, and expectations imposed by the tool itself. As it's demonstrated in some works related to visual programming in music (Pošćić and Kreković 2018), programming for music is often used by looking at tutorials and code examples on the internet. This learning process might significantly influence the later creative output of a musician.

The second type of improvisation in live coding relies on prewritten or composed music. In this case, the code that generates the music is prepared and written in advance of the actual performance. During the live performance, the musician makes interventions in certain segments of the code and thus modifies the music in real-time. This approach coincides with the traditional position of improvisation in jazz subgenres like hard bop. Even though it might seem restrictive at first glance, and unlike improvisation in bop, the possibilities of improvisation based on the set code are limitless as there are no imposed restrictions on how much of the code the musician can modify.

Finally, the third modality of improvisation in live coding presents a middle road between the two previously described options. Here musicians prepare snippets or segments of code in advance, either as starting points for spontaneous compositions or building blocks to be used throughout. We can say that these blocks of code represent "themes" that then get evolved, elaborated, and chained to each other. Based on the available body of work in live coding, it appears as the most commonly used modality.

In all of these cases, the creative process is largely influenced by the characteristics of the tool of choice. Notable live coding environments like TidalCycles and Impromptu seem to impose a certain aesthetic lineage on performances and works created in them. Simultaneously, tools that employ contrasting graphical paradigms like the Threnoscope (Magnusson 2014) induce different stylistic traits in the works produced in them. Whether these phenomena are direct results of unavoidable characteristics of these tools or consequences of more complex socio-cultural interactions (like learning methods and influence through communities) is an interesting question, but beyond the scope of this paper.

4 AN INVESTIGATION THROUGH PRACTICE

As an extension and complementation to a theoretical view on improvisational live coding practices based on pre-existing parts of code, this study includes investigated possibilities, generalized observations, and experienced implications obtained through a practical part of the research. Following the paradigm of improvisation grounded on modifying and triggering prepared code, one of the authors composed music for a full-length contemporary choreography using TidalCycles, a textual programming language and an extensive library for live coding (McLean and Wiggins 2010). The selection of the tool implied the pattern-based approach which significantly influenced various conceptual, aesthetical, and practical aspects. The hands-on experience enabled us to investigate the scope of improvisational interventions and their consequences on the musical aspects, but also on the performance as a holistic multimedia entity.

4.1 Motivation and Hypothesis

The main expectation from preparing code segments in advance was to create a plateau, a mature starting point that transitions the focus from building basic elements to handling complexity and nuances during live performances. Obtaining aesthetically refined results by writing code from scratch requires experimentation and takes time. In the context of accompanying dancers and video projections, timing in music is not arbitrary, but it depends on other performative elements. Live coding based on prepared code segments was expected to offer an appropriate balance between the pre-arranged dramaturgic evolution, pre-composed themes, and intentional occasional synchronicity between dance and music on one side and spontaneity, adaptability, and unexpected interactions on the other. Therefore, the aim was to prepare a certain set of musical ideas in advance and use them as an improvisational material through modifications, reductions, and extensions.

Code development began soon after the choreographer and the dancers started experimenting with dance movements and overall atmospheres. A vague outline of dance sequences inspired the initial organization of predefined musical phrases which were expected to evolve during time.

During the course of time, the dance sequences became longer, more structured, and more nuanced; some sequences were abandoned, while several new parts emerged to fill gaps. The similar approach reflected on the music creation process which—thanks to the established paradigm—allowed a lot refinements, evolution of complexity, cumulative definition of aesthetic consistency, and finally, iterative alignments with choreographic, scenographic, and visual elements of the performance.

4.2 Scope of Improvisational Interventions

Fig. 1.
Live coding for contemporary choreography

Timing is the first improvisational operation that is specific for being a variable aspect of live coding that exists even when the code stays unchanged during performance. If not explicitly chained in advanced, blocks of code stay independently and produce cyclic patterns when triggered. In the context on musical aesthetics built on repetitions, isorhythms, and changes, a possibility of controlling pattern duration and timing is an operative aspect of influencing the musical composition on the meso and macro time scales (Roads 2004). Additionally, such a possibility facilitates the coordination between music, dance, and multimedia elements. Longer repetitions during rehearsals allowed dancers to accommodate to certain musical moods and develop the quality of movement appropriate to those music phrases. When the dance sequences became more matured and defined, manual execution of code blocks had an important role of maintaining the overall flow of the performance – sometimes the progression of music waited for appropriate changes in dance, while in other cases the dancers were triggered by changes in music. Aside from all conceptual and practical benefits, when it relates only to executing unchanged code, the intentional variability of timing can be barely considered as an improvisational intervention.

Regarding the actual changes in the code during live performances, they can be categorized to 1) modifications on the sound object level, 2) modifications on the pattern level, and 3) creation of new patterns.

Modifications of sound objects refer to changing particular elements of music patterns. In practice, these elements are sound samples and they "generalize the traditional concept of note to include complex and mutating sound events on a time scale ranging from a fraction of a second to several seconds" (Roads 2004). Subsequent modifications of sound objects break the continuity of repetitions and allow improvised transformations of musical phrases in real time. In this context, timing is crucial, because the changes are not audible immediately, but only after the following cycle starts. The possibility to control sound objects combined with deliberate timing brings live coding closer to the experience of playing a musical instrument, as sound objects relate to melodies and textures at the compositional meso level. In practice, this technique has been applied to tonal phrases in which the changes of leading tones created melodies. An example is a repeating arpeggio whose highest tone changes in each repetition following a melodic line, while other tones stay the same. Another purpose of this technique in our experimental practice was to mitigate monotonicity of periodic sonic textures created by chaining different sound objects with noisy qualities. Although it could have been achieved programmatically by the random selection of sound objects, manual interventions allowed more adequate reactions to the situations on the scene and more active engagement by the musician.

Modifications on the pattern level affect the whole patterns, as they usually target functions that control the sample playback parameters, sound effects, and the pattern's structure. By adding, deleting, substituting, and re-parameterizing those functions, the musician can significantly reshape the building sonic material. The changes introduced this way were very important in our practical setup, since the set of underlying sound samples was intentionally reduced to a sonically consistent and hermetic scope. One of the reasons for such a reduction was to motivate the exploration of live coding possibilities, while maintaining the conceptual consistency. Consequently, modifications on the pattern level became the main mechanism for introducing gradual advancements that perceptually differentiated the generated music from the raw building material. They served as a mean of sonically significant interventions during live performances that were sometimes applied on different simultaneously playing patterns in quick iterations to totally dissolve repetitions into lively and organic transitions between sonic variations.

The third mode of intervention is writing new code segments from scratch. The fact that we opted for a paradigm based on pre-existing code did not prevent us from adding new code during live performances, as that approach offered the maximal spontaneity and the widest range of expressive possibilities. Moreover, since there were a lot of already prepared code segments, their execution created some additional time to write new code while existing was producing music. It turned out that such a practice usually resulted with changes that were not expected by the dancers. Namely, the dancers were used to known material and its incremental changes, so any significantly different pattern positioned them in a new musical context. As the dance sequences became more defined and predictable during rehearsals, the range of improvisational interventions by adding new code also decreased. However, live coding from scratch remained as a useful mechanism for breaking excessive repetitions and for introducing new musical content in cases when dancers prolonged their sequences either deliberately or forced by specific situations on the scene.

4.3 Repeatability and Accumulative Nuancing

Through the previous discussion about improvisational possibilities, we touched upon the fact that the complexity of musical content increased by accumulating changes introduced following the improvisational practice during rehearsals and live performances. This was possible because of the exact repeatability achieved by saving the changed code. While it may seem as a trivial consequence of a textual editor's basic functionality, the possibility to exactly store results of improvisational interventions and use them as a starting point for future interventions is an idiomatic and unique characteristic of live coding.

The reason is that the information is stored at the first level of mapping musical ideas into music – on the code level where only the functions for creating patterns and structures exist. It is before actual patterns are formed, before they trigger sound objects, before sound objects are reproduced and processed, and before a resulting audio signal is transformed to sound. This unique situation is a result of the fact that program code almost directly represents any algorithmically formed idea. When playing a musical instrument, ideas are first converted into physical actions and the first level at which the information can be stored is a trace of those actions, such as MIDI signal. There is no way to capture the idea earlier, because it has been already transformed to actions before being expressed in an algorithmic form. While it is possible to modify MIDI, such modifications follow a different paradigm from the one used to capture the actions for the first time. It is not possible to improvise by editing the MIDI content in the same way as the musician has improvised when the content has been created. On the other hand, in live coding, those paradigms are unified - creation and modification are both done on the level of algorithmic ideas.

The specificities of the medium also entail a consensus about valorisation. In a traditional sense, improvised music is valued for being unique and its reproduction on the performative level seems absurd. In fact, it is so absurd that the notion of such a note-for-note copy could be a strong statement itself, as demonstrated by Mostly Other People Do The Killing and their album Blue which is a remake of Miles Davis' album Kind of Blue (Corotto 2014). On the other hand, the reproducibility in live coding is an idiomatic characteristic that is achieved by a trivial action of saving the changes in the textual editor. However, by that action, results of improvisational interventions become a part of the algorithmic corpus and loose the quality of uniqueness. When such improvisational interventions are chained one after another, a constant evolution of the generative medium is achieved.

In practice, the repeatability and cumulative improvisations enabled a gradual exploration and creation of the material for the performance. The first iterations resulted with crude and sonically unrefined musical ideas that followed the structure of dance sequences that were also in the embryonic stage at that time. During the rehearsals with dancers, the ideas evolved and all the interventions to the code accumulated resulting with the musical content that is more complex and more nuanced. The evolution continued during performances, even though the incremental changes decreased as the music and choreography converged.

5 CONCLUSION AND FUTURE WORK

With this paper we have accomplished two goals. First, we gave an overview of improvisation in its historical context and, more specifically, in the realm of live coding. By doing so, we identified common threads shared between traditional, live electronics, and computer-aided improvisation. The collected and presented previous studies show how improvisation in some form is a key part of many music genres and a fundamental element of live coding.

From there, we argued that the modalities of improvisation in live coding could be categorised into three types based on the amount and nature of pre-written code. Using a case study based on a live coding accompaniment for a contemporary choreography, we further investigated one of these modalities. In it, a musical score in the form of pre-written code gets considerably modified during the live performances and made to follow the interaction between dancers. We also explore in detail the process of creating this piece of music and the modalities of its transformation during the performance. Within these spontaneous transformations, the influence of non-musical elements, in this case the movements of dancers, also becomes a factor. Likewise, our research shows that improvisation plays a significant part for the whole duration of the creative process, not only during its performative segments. Based on the presented case study, we argue that no artistic merit is lost when reproducing previously improvised music which has then been made "permanent" in code.

The second goal of this paper was to start a discussion and to set the stage for explorations of improvisation in live coding beyond these existing roles and modalities. This discussion should look both at the findings outlined in this paper, the historical importance of improvisation, and its state-of-the-art role in live coding. Future works might explore how tools like TidalCycles can be remade to challenge musicians and enable them to break free from patterns and habits. This could be, for example, accomplished through the use of artificial intelligence methods and adversarial systems. New tools should also be considered to shift the live coding paradigm, perhaps bringing it into the visual domain. Finally, cognitive dimensions of live coding should be researched to try and understand the relation between tools' characteristics and the aesthetic determinism of music created in them.

The research presented in this paper shows that a deeper investigation of the role, position, and potential of improvisation in live coding is still necessary. It is our hope that by challenging the notions and understanding of improvisation and by relying on advances in human-computer interaction, new creative avenues can be discovered.

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Between Chaotic Synthesis and Physical Modelling: Instrumentalising with Gutter Synthesis

Keywords
chaotic synthesis
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gutter synthesis

This paper presents the Gutter Synthesis project, a synthesis method that combines chaotic synthesis based on the Duffing Oscillator dynamical system with modal-like resonances. The synthesis process is described and the project is related both to prior work on chaotic synthesis and to relevant perspectives from physical modelling. A range of specific kinds of interactions with the synthesis engine are considered, supported by accompanying videos. These interactions demonstrate the complexity of behaviours that can be encountered when interacting with chaotic systems, particularly in relation to hysteresis. The potential of the system to enter different states, and for unstable boundary points to be explored as creative resources are considered and linked to Andy Keep's notion of *instrumentalizing*.

1 INTRODUCTION

Gutter synthesis is the name given to the specific synthesis process described in this paper, to the software,[1] and to a CD release of sonic explorations of the synthesis process (Mudd 2018). The project explores the overlap between the well-trodden fields of chaotic synthesis on the one hand and physical modelling on the other. The motivations behind research in the two domains can often differ, with physical modelling attempting to mimic, understand or expand on existing acoustic situations, and chaotic synthesis exploring very digital, artificial and potentially noisy systems. Nevertheless, both make frequent use of nonlinear dynamical systems, and exploit the potential for these systems to produce a variety of tones and timbres through fixed sets of rules. The sound world afforded by the Gutter Synthesis software is deliberately acoustically inspired, with the noisy proclivities of the chaotic synthesis processes constrained by sets of modal resonators that behave in a manner analogous to the bore in blown instruments or the string in bowed or struck string instruments.

1. The software is available at https://github.com/tommmmudd/guttersynthesis

This paper explores *interaction* in relation to the Gutter Synthesis software, and hence in relation to acoustically inspired chaotic synthesis processes. The complex nature of the system's behaviour in response to even relatively simple inputs permits a highly exploratory engagement, where the user may not always be sure how the instrument will respond. This is linked here to Andy Keep's notion of *instrumentalizing*: the process of exploring sonic objects and responding to their inherent (but often hidden) sonic properties (Keep 2009) This is as opposed to, for example, bringing a pre-formed musical language to the object and trying to govern the response of the object in relation to that pre-formed language. Keep connects this approach with experimental contemporary music, and in particular free improvisation, but it can also be linked to contemporary computer music practices (Mudd 2017). An important corollary of Keep's focus on the act of exploring objects and instruments as material is the emphasis that this puts on interaction. In the case of digital tools particularly, it is not straightforward to create software that has scope for nuanced exploration, and that has the potential for hidden elements to be uncovered and developed. Chaotic synthesis is explored here as a method for permitting these kinds of creative engagements in digital interactions, a point that is made clearer through the inherent link with physical modelling.

In order to address the nature of possible interactions with the Gutter Synthesis software, a series of short demonstration videos[2] accompany this paper, which provide examples of the specific kinds of interaction discussed, showing how the audio engine responds to particular changes in input. It is also recommended that the software is used alongside the reading of this paper to support a more thorough understanding of the discussion.

2. Available at https://vimeo.com/album/5707465

2 CHAOTIC SYNTHESIS AND PHYSICAL MODELLING

Chaotic synthesis has multiple roots, depending on how the field is defined. The cybernetic experiments of the 1960s, electrical feedback experiments of David Tudor (Kuivilla 2004), and perhaps more specifically the implementations of Rössler's equations as video and sound synthesis processes were developed and explored by a range of artists. A wide range of other dynamical systems have been applied in both digital and analogue settings for a variety of reasons. The use of such systems is often motivated by a desire to explore and exploit the complex, emergent behaviours that they exhibit: their ability to move between ordered oscillations and more unpredictable and turbulent states (Degazio 1993; Mackenzie 1995; Radunskaya 1996; Scipio 1990) and often their potential to structure not only micro-level timbral aspects, but also macro-level structural aspects (Pressing 1988; Scipio 1990).

Physical modelling has a parallel history, emerging from initial experiments with voice synthesis in the 1960s (Välimäki et al. 2006). McIntyre, Schumacher, and Woodhouse (1983) provide a highly simplified but useful characterisation of musical instruments as composing a nonlinear element coupled to a passive linear element, shown in Fig. 1. The former can represent the behaviours of reeds, bowed interactions, air-jet behaviour, and so on, while the latter can represent the response of a string or a tube.[3] The connection between chaotic synthesis and physical modelling has been made explicit by a number of authors (Dobson and Fitch 1995; Radunskaya 1996; Truax 1990). Although the two domains may start with very different motivations, they arrive at a similar place in terms of digital synthesis processes. Physical modelling synthesis algorithms are generally discrete renderings of nonlinear dynamical systems that are very similar to the kinds of systems explored through chaotic synthesis. This can be seen clearly in, for example, the delay-based digital waveguide approach to physical modelling (Smith 1992), and in finite difference models (Bilbao 2009).

3. Although see Bilbao (2014) for further nonlinear behaviours in these "linear" elements

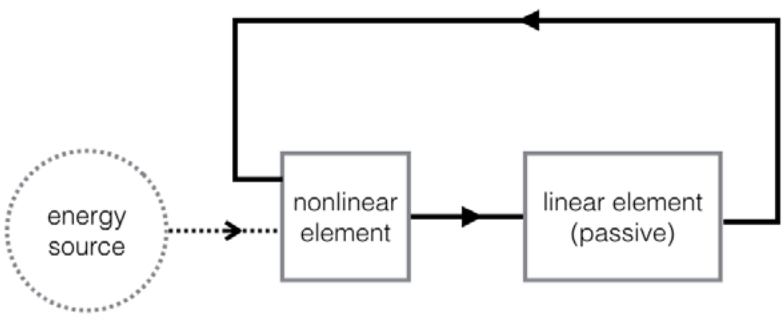

Fig. 1.
An idealised block diagram description of musical instruments as a coupling of a nonlinear element coupled with a passive linear element, as exemplified by brass, woodwind or bowed instruments, after McIntyre, Schumacher, and Woodhouse (1983).

The Gutter Synthesis process described in the next section is based largely on chaotic synthesis, but draws on elements of physical modelling—particularly the simplified model of an instrument shown in

Fig. 1—in order to permit a continuum between explicitly electronic sounding noises, and outputs that sound plausibly acoustic, resembling physical situations such as rattling plates or scraped strings.

3 OVERVIEW OF THE SYNTHESIS PROCESS

The synthesis algorithm is based around a discrete map of the damped forced Duffing Oscillator. This is a relatively well understood nonlinear dynamical system (see Ott, Sauer, and Yorke (1994), Thompson and Stewart (2002), and Ueda (1980) for example). In the Gutter Synthesis implementation, the oscillator is coupled with a set of up to 24 bandpass filters. This makes the system resemble the simplified block diagram of musical instruments presented shown in Fig. 1: a nonlinear element is coupled with a linear passive element, and driven by an external energy source (akin to the forcing term in the Duffing oscillator in this instance). The Gutter synthesis software connects together eight of these coupled resonant Duffing voices into a dynamic network. Each voice is created as a Java object instantiated in MaxMSP inside the mxj~ object. The Duffing oscillator is described in more detail below, followed by the coupling with the bandpass filters, and an overview of the network.

3.1 The Damped Forced Duffing Oscillator

Notably for this work, the Duffing Oscillator is already a physical model in that it models a rigid beam that is driven by an external oscillating force (Thompson and Stewart 2002). The system is usually constructed as follows (Guckenheimer and Holmes 1983):

$$\ddot{x} + k\dot{x} + \alpha x^3 = Bcos(\omega t) \tag{1}$$

where k, α, B and ω are potentially controllable coefficients, and t is continuous time for the forcing term Bcos (ωt). This can be rendered as a discrete map:

$$\begin{aligned} x_{n+1} &= y_n \\ y_{n+1} &= -ky_n - \alpha x_n^3 - Bcos(\omega T_n) \end{aligned} \tag{2}$$

where $T_n \in Z+$. Direct sonifications of the Duffing system have been explored by Degazio (1993) and Dunn (2007), and it has been used as a control for synthesis parameters by Spasov (2015). Despite the relative simplicity, the system exhibits a range of complex phenomena around bifurcation points (Lakshmanan and Rajasekar 2003).

3.2 Coupled Resonance

The coupling with the resonance acts as a function on x_n in the discrete map. Each term x_n is run as an input to the set of bandpass filters, the output of which, $f(x_n)$, is used in place of x_n in Equation (2):

$$
\begin{aligned}
x_{n+1} &= y_n \\
y_{n+1} &= -ky_n - \alpha f(x_n)^3 - Bcos(\omega T)
\end{aligned}
\tag{3}
$$

This can be seen in Figure 2. These filters effectively act as constraints on the Duffing oscillator, supporting oscillations at certain frequencies at the expense of others in a manner analogous to the regulating of a reed's behaviour by the impedance spectrum of an instrument's bore. With higher resonance settings, the filters can effectively prevent noisier behaviours, forcing the oscillations into the specific frequencies present in the filters. Decreasing the resonance allows for more chaotic regimes to develop, unconstrained by the filters. The result is a combination of the complexity of behaviour found in the raw nonlinear dynamical system with the more resonant and potentially more harmonic aspects of the filters.

The output of the filters is further constrained through a controllable lowpass filter that can optionally prevent the more abrasive high frequency content, and an arctan limiter to artificially constrain the output into the range ±1.

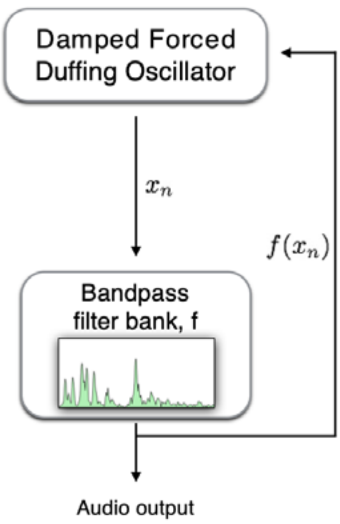

Fig. 2.
Each voice in the Gutter Synthesis software is a Duffing oscillator coupled to a set of bandpass filters.

3.3 Interactions Between Multiple Oscillators

The description given above describes an individual synthesis voice in the Gutter Synthesis program. A key aspect of the project is the coupling of up to eight voices. This is achieved by routing the output of each voice to the damping parameter, k in Equation (3), of every other voice at audio rate. This connection can be scaled to increase or decrease the amount of influence that each voice has on all other voices, but the parameter is constrained: $0.0001 \leq k \leq 1$. The constraint means that the audio signal—which can be positive or negative—will cause the damping to fluctuate.

A 2000 sample delay is placed in between each voice output and the damping inputs of each other oscillator. This lag appears to help the system as a whole to keep undulating, rather than quickly stabilising to a particular state.

4. CONTROL AND INTERACTION

This section looks at specific points of interest in interactions with the synthesis process. The parameters available in controlling the system are established, showing how they can be used to interact with the nonlinear dynamical system in different ways. The text descriptions of the interactions and the system's behaviour are supported by five video examples that can be found at vimeo.com/album/5707465. Interactions are examined first in relation to a single synthesis voice, then in relation to the interlinked network of eight voices.

The user interface for the synthesiser is shown in Fig. 3. The controls apply to all eight voices (a separate control panel can be used to alter the voices individually). These parameters relate to the equations above as follows:

- the *gain* parameter is inside the resonant Duffing loop, scaling the value of $f(x_n)$ in Eq. 3 rather than an external gain, and therefore affects more than just the level of the output;
- the *damping* parameter is k in Eq. 3, as noted earlier;
- *mod* is the driving amplitude, B;
- *rate* alters the driving frequency, ω;
- Q controls the resonance of the bandpass filters;
- *soften* controls the smoothing for the lowpass filter within the resonant Duffing loop;
- *oscillator interaction* alters the scaling of the connections between each voices output and the damping value for all other voices;
- *pitch shift* scales the frequencies of all bandpass filters.

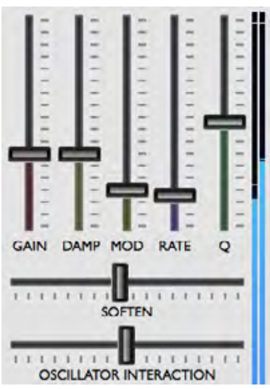

Fig. 3.
The interface for the Gutter Synthesis software.

4.1 Hysteresis and harmonic hopping

A key aspect of the interaction with chaotic systems is the potential for hysteresis (Mudd et al. 2015). The current state of the inputs to the system is not sufficient to determine the sonic behaviour. The prior state of the system, and hence the prior input to the system also plays an important role. This can be seen in the use of a single synthesis voice. Consider the system as represented in Equation (3) with the modulation, B, set to zero (an unforced Duffing oscillator). With the gain, resonance (Q) and modulation fixed at particular values, decreasing the damping tends to destabilise the perceived pitch being produced such that the system may snap to a different frequency, generally jumping to a different resonant frequency in the filter bank. The damping can then often be returned to its original value whilst retaining the new dominant frequency. This is shown in video number 2 in the accompanying online material. This "harmonic hopping" can also be heard with variations in other parameters such as resonance and gain (videos 3 and 4). This kind of interaction can be thought through visually in relation to the butterfly-like patterns created by the Lorenz attractor: if the user has real time control of the system parameters, they can find the boundary at which the trajectories settle into one "wing" or another of the butterfly, and cross and re-cross this boundary to hop from one orbit to the other (Mudd, Holland, and Mulholland 2019).

4.2 Constraining chaos with the resonant filter bank

With the resonance parameter at its minimum, the noisier tendencies of the raw Duffing oscillator can come through unconstrained. This is shown in video number 3 for a single synthesis voice, where the resonance parameter is increased from the minimum value until a stable pitch is produced. The system undergoes a series of seemingly discontinuous changes, moving from pulsed clicks through broadband noise bursts towards a stable low pitch, which rises slightly as the resonance approaches the maximum. The filter resonance becomes a useful way of constraining the more unpredictable aspects of the system: higher resonance values provide much more stable pitch outputs. The parameter can also be used to hop harmonics as noted above, where the parameter is lowered until the system hits a less stable point, a different tone emerges (usually closely related to the frequencies present in the filter bank) and the parameter can then be increased again to stabilize this new tone.

4.3 Holistic mapping

Chaotic synthesis processes and physical modelling present examples of a holistic mapping processes, as described by Hunt and Kirk (2000). Individual perceptual aspects are rarely controlled by individual parameters (e.g. separate controls for pitch, volume, brightness, etc.). This is demonstrated in video number 4 which shows how a single synthesis voice undergoes a range of transitions as the gain parameter is increased and decreased. To begin with the gain behaves almost like a volume control. As it is increased further, the tone starts to distort as other frequencies appear, with the tone eventually moving away completely from the original frequency to land more prominently on other harmonics. A range of unstable behaviours emerge for very high values, with rhythmic fluctuations in the presence of different harmonics. Figure 4 shows how the system can fluctuate by itself while the input parameters are left unchanged.

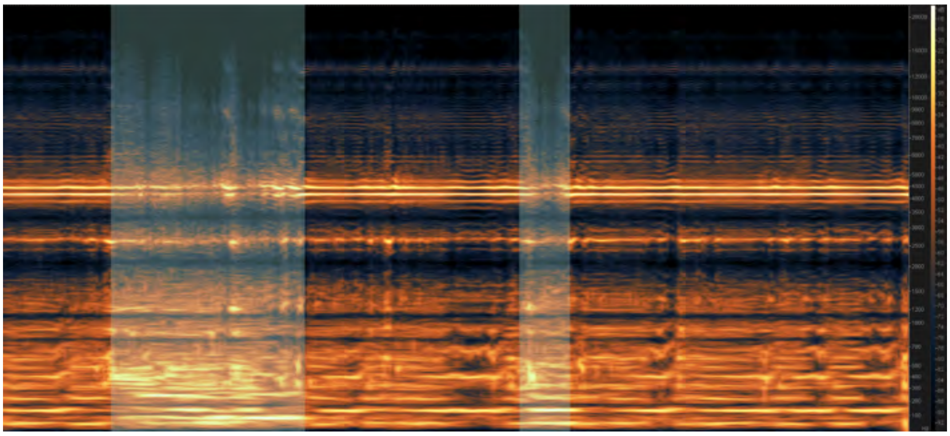

Fig. 4.
A sonogram showing four seconds from example video number 4 (1'17 to 1'21) where the parameters are unchanged. A range of frequencies are present, and the system can be seen to fluctuate between clear higher frequencies, and lower frequency rumbles (the latter are indicated by the blue shading).

4.4 Oscillator interactions

Video number 5 shows how the oscillator interaction processes change the behaviour of two synthesis voices. The two voices have different filter banks with different sets of frequencies (randomized logarithmically between 50 and 2000 Hz). The two voices are initially relatively stable, with distinct pitch identities as shown in Figure 5. The oscillator interaction parameter is increased from minimum to maximum (shown with the blue shading), which increases the extent to which the audio output from each voice affects the damping parameter of the other voice, as described at the start of this section. Three full sweeps of the parameter are shown in Figure 5, alongside the spectrogram of the two oscillators.

A first observation is—as can clearly be heard in the video and seen in the image—the response tends to be noisier as the interaction parameter is increased, with bands of noise around the resonant frequencies. Secondly, as with the variation in damping described above, the synthesis voices can be seen to make abrupt changes at two points. As Figure 5 shows, this is not an instant response to the particular value of the interaction parameter. The first jump is made as the parameter is held at ≈95%, with a switch in the key frequencies. Thirdly, it is somewhat surprising that there are *two* jumps. The first jump at around 45” is not a final resting place for the oscillators. When it is returned to 100% for the second time at around the 1'09 mark, both voices make a further jump to stabilize around much lower frequencies. These are maintained throughout the third sweep, with no discontinuous changes occurring.

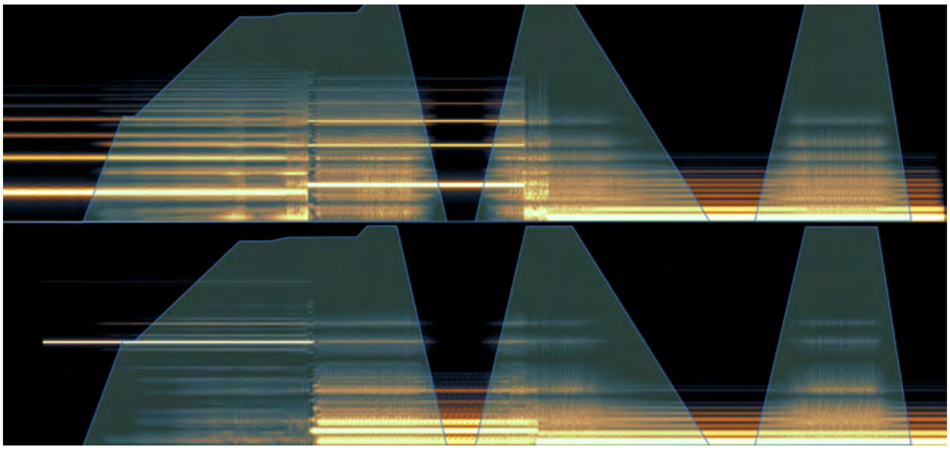

Fig. 5.
A sonogram of video number 5 (from 0'00 to 2'00) showing how two oscillators respond as the "oscillator interaction" parameter is varied. Three staggered sweeps are shown from 0-100% of the oscillator interaction parameter, indicated by the blue line.

5. DISCUSSION

Interactions with chaotic synthesis processes are often likened to collaboration with separate agents (Burns and Burtner 2004; Clutterbuck, Mudd, and Sanfilippo 2016), a refrain that can be also be found in relation to acoustic instruments in free improvisation (Borgo 2013; Lewis 2017; Unami 2005) and to hardware electronic sound making devices, as Keep notes in particular in relation to David Tudor (Keep 2009). In tracing his concept of *instrumentalization*, Keep highlights the importance of "bastardization"[4], pushing systems to do things they weren't made to do, and finding "fruitful edge-boundaries of unstable sonic activity". It is not always so straightforward to find these kinds of unstable boundaries in digital interactions however; the interface can only be bastardised so far. Chaotic synthesis processes provide one such way of realising this kind of interaction in digital contexts. In particular, the complex behaviours that can be found close to and across bifurcation points in chaotic systems appear to support this kind of edge-based interaction (Mudd, Holland, and Mulholland 2019).

4. A term borrowed from John Richards.

The interactions traced above demonstrate this in relation to the Gutter Synthesis software, highlighting regions where unexpected things can happen, that neither the software designer nor the user can reliably predict. The set of possible outputs is not a sum of the possible inputs. Hysteresis permits even a single parameter to be explored almost endlessly, as what matters is not only the value of the parameter, but the current state of the system, and hence the history and timing of the user's input. Even a relatively low-resolution, single dimension of input may then be a source of considerable exploration, as shown in relation to the gain parameter in section 4.3 or the interaction parameter in section 4.4. When the system jumps to a new state, the nature of how it responds to different values of the input parameters can be very different. The fact that the system may take some time to transition to a new state (as shown in section 4.4) highlights the importance of timing and of rate-of-change in the user input. Moving a slider from point A to point B can yield very different results depending on how fast it was done, how long it was left in different regions in between and so on. The sound being made at point B could be radically different if the movement was very gradual, compared to the same movement performed very rapidly.

The link between chaotic synthesis and physical modelling demonstrates a connection between these kinds of digital interactions and real-world interactions encountered in acoustic musical instruments. Indeed, some of the kinds of interactions found in acoustic instruments may be down to their potential for chaotic processes. The same kind of hysteresis discussed above in sections 4.1, 4.2 and 4.3 can be found in interactions with wind instruments (McIntyre, Schumacher, and Woodhouse 1983) and bowed strings (Fletcher 1999) for instance. Considering the role that chaotic processes and nonlinear interactions play in other domains may also be instructive. Paint and paintbrushes afford similar kinds of interactions: both the tool and the medium exhibit hysteresis in different ways: the bristles can be considered as a set of interconnected springs (Chu and Tai 2002), and the paint itself alters its behaviour as it dries (Baxter, Wendt, and Lin 2004; Chhabra 2010). As with instrumentalizing approaches to music, the complexity of interaction appears to afford particular kinds of creative enquiry and exploration that engage with these complexities.

6. CONCLUSIONS

This paper has introduced the Gutter Synthesis project as a linking point between chaotic synthesis on the one hand and physical modelling on the other. Specific interactions with the synthesis processes have been considered that highlight the role of hysteresis in exploratory engagements. Chaotic synthesis processes in general were linked to the edge-like or boundary-based interactions that Keep describes in relation to his concept of instrumentalizing: drawing creative inspiration from the specific properties of sonic objects. Boundary points in interactions with the Gutter Synthesis process were examined, along with the rich and complex behaviours that can be found around these boundaries. The time-based nature of interactions with systems that exhibit hysteresis is considered, and put forward as a useful method for setting up digital interactions that can be fruitfully explored, even with a small number of low-resolution inputs.

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nonhuman turn
play
animal-computer interaction
interspecies

Interspecies Playful Interaction: Towards the expansion of interaction design

In this work we explore a change of perspective on interaction design in favour of a nonhuman turn. We highlight animal studies, especially those that extend to them the notion of play, as well as studies on playful design and interspecies playful interaction, conducted in the context of animal-computer interaction. This discipline adopts an animal-centred approach and its research has been showing the benefits of enhancing interspecies relationships driven by the design of interactive technology. In this context, we propose to expand the field of interaction design as an approach to the connection with the nonhuman world by assuming an ecological perspective in which empathy is a key factor.

1 INTRODUCTION

The boundaries of the field of interaction design, whether they are cultural, technical, or methodological, are in a constant process of expansion. These changes started being more significant by the end of the 1990s, when designers began to encounter new challenges that resulted from the interest of exploring complex and ambiguous topics such as feelings, emotions, experiences, meaningful practices (Mattelmäki et al 2014). These led to the need of finding new approaches that could enable designers to deal with uncertainties resulting from the insertion of these issues into the design process, and to come up with possible design solutions.

The answers to this marked a design approach responsible for approximating designers and users in the context of the creative practice, a context where empathy appeared as a key factor. This happened with the introduction of the notion of *empathetic design* (Leonard and Rayport 1997), a set of techniques grounded in an observational approach, from which designers may potentially assess the needs of potential users by watching the course of their everyday routines in their own environment. Afterwards, around 2003, design culture began to change from products to one that includes a form of immaterial design, that is, to processes, systems, services, forms of communication and collaboration (Brown and Wyatt 2010).

The empathetic design perspective shifted to the notion of co-design (Rizzo 2010), enticing non-designers to express their ideas and take part in activities related to the design process. One thing to keep in mind is that when we talk about co-design or participatory design, we are also referring to empathy. The construction of empathy is established by an aesthetic relationship formed by learning the qualities and values of another. This dialogic and immersive process can take time until the designer is able to recognize behaviours and strategies that people use to cope with the complexities of the world. The perception of these behaviours is subsequently translated into designs for systems and services that can impact the lives of individuals. In this context, the designer appears as somewhat of a cultural intermediary.

It was also around the early 2000s that the term *design thinking* (Brown 2009) gained prominence. Emerging in a context where organizations were seeking for innovation, the principle behind this human-centred, creative, iterative, and practical approach (Brown 2009), was to spread the idea that the way in which designers deal with complex problems could be learned and employed by anyone (even by those who never imagined themselves as designers) in any context, to solve any type of problems.

More recently, terms such as design *fiction* (Sterling 2005, Bleecker 2009) and *speculative design* (Dunne and Raby 2013) also emerged. These practices critique the business role of design and set out a broader notion anchored in a cultural, social, and political context. Design fiction is related to speculative practices of looking far into the future towards better ways of living in society and culture. This is a fertile environment for interaction designers to dive into, since the future will likely be rich in computational devices and technologies of intelligence. A fictional design does not necessarily develop solutions but through it designers can probe, question, critique, and explore scenarios of possible futures by using narrative, diegetic prototypes, and context (Levine 2016). However, the elements presented in a fictional scenario must follow certain rules in order to be effective (Tanenbaum 2014), thus the practice of future-making also demands an awareness of the present. Like as on the previously mentioned design practices, the human and social fundamental practices are among the main issues examined on the fictional scenarios (Bleecker 2009).

Despite the expansions of the field of interaction design in favour of a user-centred approach, we may say that its strategies are still largely based on principles that place the human at the centre of the design process and hence towards the understanding of human qualities and needs. In contrast of this human-centred design, there is an emergent perspective that has been brought by a movement engaged in a turn towards the *nonhuman*, that can be understood "in terms of animals, affectivity, bodies, organic and geophysical systems, materiality, or technologies" (Grusin 2015, Morton 2017).

In light of this, we look at interaction design seeking to raise awareness in favour of a nonhuman perspective that may benefit the field by expanding to other species. Thus, we discuss the repercussions of this perspective in the context of interspecies playful interaction conducted by the discipline of *animal-computer interaction*. We present insights into animal play and interspecies relations through empathetic connections. Then, we propose notes towards an expansion of the field of interaction design as an approach to connecting with the nonhuman world.

2 CHANGING PERSPECTIVE ON DESIGN

The concern towards nonhumans is not new, but it is gaining strength after the post-humanism studies of the 1980s. Grusin (2015) points out that the recent intellectual and theoretical studies engaged in the broad spectrum of the nonhuman are: actor-network theory, affect theory, animal studies, assemblage theory, new brain sciences, new materialism, new media theory, varieties of speculative realism (like object-oriented philosophy (Harman, 2018) and panpsychism), and systems theory.

Throughout these fields we emphasise animal studies, especially two approaches that extend to them the notion of play. Playful activities may be characterized by five criteria that can be summarized as: "play is repeated, seemingly non-functional behavior differing from more adaptive versions structurally, contextually, or developmentally, and initiated when the animal is in a relaxed, unstimulating, or low stress setting" (Burghardt 2014).

Considering that playful activities precede the idea of culture (Huizinga 1949), they are not exclusive to humans. Until recently, the idea of "true" play was only attributed to mammals and some birds (Burghardt 2014), while possible play manifestations in other species were dismissed as anecdotal, anthropomorphic conceits, misinterpreted functional instincts, or immature behaviour (Burghardt 2005). We have now evidence of play behaviour in a wide range of animals, including turtles, lizards, fish, and invertebrates (Burghardt 2005).

Since playful activities are a common behaviour of several animals, it seems to be a potential way to facilitate the connections between interspecies animals. Moreover, the element of fun in playing may resist "all analysis, all logical interpretations" (Huizinga 1949). One example of the intensity of the interactional bonds created by a playful experience was captured by the lens of the nature photographer Norbert Rosing (see Fig. 1). He witnessed the uniqueness of the encounter of a polar bear playing with a dog in the sub-arctic wilderness of northern Canada. As improbable as it may seem, these play sessions happened for ten days in a row.

Fig. 1.
Images shown a polar bear playing with a dog captured by the nature photographer Norbert Rosing.

Second, the studies on interspecies playful design and interactions conducted in the context of Animal-Computer Interaction (ACI). The development of technology intended for animals is not recent (Mancini 2011), however, Mancini highlights that the design of most of these technologies is not necessarily led by user-centred principles, since animals may not have control over its interaction. Furthermore, "there is an underlying expectation that the animal will adapt to the technology rather than the other way around" (2013). ACI's efforts propose the application of design principles that place the animal at the centre of an iterative development process as a legitimate user and contributor of design.

Such approach is much more recent, and research has been exploring it in such distinct ways. A literature review (Hirskyj-Douglas et al. 2018) on the interactive technologies involved in the context of ACI presented the following classification: tangible and physical objects, haptic and wearable technologies, olfactory interfaces, screen interfaces, and tracking mechanisms. These technologies used several interfaces such as animal-robotic, button systems, biotelemetry and GPS collars, vibrotactile vest, smell, thermal cameras, and touchscreens; they aimed at control, communication, working, monitoring, enrichment, playful, among others; and involved several species, like chickens, pigs, dogs, elephants, cats, and horses.

Playful interactions are being increasingly explored in ACI. Its research has been showing benefits on enhancing interspecies relationships driven by the design of interactive technology. As a consequence, the practices of interaction design and game design are becoming recurrent (Cheok et al.

2011, Alfrink et al. 2013, Westerlaken and Gualeni 2014, Geurtsen et al. 2015, Baskin and Zamansky 2015, French et al. 2018).

Since the ludic aspect is intrinsically motivated, realized by the pleasure resulted from the activity itself, and only occurs at times when the individual is not subject to stress situations (Oliveira et al. 2010), it represents a welfare characteristic. In addition to this, Haraway (2008) argues that play activities make an opening for a pleasurable and voluntary encounter between human and animals where coevolution processes which characterize interspecies relationships can take place. “The taste of ‘becoming with’ in play lures its apprentice stoics of both species back into the open of a vivid sensory present” (2008). We believe that these encounters may also be a way to empathy promotion and facilitate a perspective changing on design.

3 INTERSPECIES PLAYFUL DESIGN AND EMPATHY

Related to the communicative, collaborative and creative process that unfolds in the relations between designers and users, empathy can be observed as the effort to connect with other on a fundamental level. Design interactions and/or games are activities that may be seen as possible ways to encourage the development of empathic forms. Those are activities that presuppose the engagement of their actors and provide immersive diving into unknown experiences and contexts.

These qualities, even though commonly seen from the human point of view, may play an important role in the context of interspecies interactions. The development of empathy may promote, among other positive characteristics, the interest in another, the apprehension of different perspectives and experiences, the expansion of communication and the tendency to make ethical decisions. Empathetic people demonstrate, for example, stronger feelings of moral obligation to help animals, plants and nature (Berenguer 2007).

In a study conducted at the Melbourne Zoo in Australia, Sarah Webber and her colleagues (2017) designed a set of interactive installations to understand the forms of empathy experienced by humans when observing animals (orangutans, in this particular case) interacting with technology. The research team identified three specific strategies to evoke empathic responses from visitors: (1) enable visitors to observe animals’ natural behaviours in close proximity; (2) make the orangutans’ cognitive capabilities visible to visitors; and (3) allow visitors to observe differences between behaviours and preferences of individual animals. For four weeks they conducted semi-structured interviews with zoo’s visitors to discuss aspects of the interaction, such as what they learned from the experience, how their perception of animals was affected, and what were their impressions about the facility.

This research showed that distinct forms of empathy were manifested. These were revealed through humans’ reflection on the animals’ intention, on desire, on learning aspects and forms of intelligence, and on similarities between orangutans and humans. These results demonstrate that interspecies empathy can be evoked through interaction design from an observatory point of view. The act of observing animals while they interact with technology can be a way of triggering perspective-taking and identity that may establish reflective thinking and different forms of connection with animals.

Patricia Pons and Javier Jaen (2017), on their turn, carried out research that allows us to observe these manifestations in the context of the design activity. Pons and Jaen conducted an experiment where children aged from 5 to 13 years, and patients in a hospital in Spain, assumed the role of game designers to create interspecies games between humans and animals. The children worked individually with the researchers in order to create scenarios for two games, each one for a different animal. Despite the fact that the animals were the focus of the project, their absence in the design activity limited and conditioned the results to the children's previous knowledge of both species and the use of technology. The results showed that many of the solutions were centred on human aspects without considering the implications of the game to the animal.

On the other hand, the experience was significant to stimulate the kids' attention to animals and positively impact their opinions related to them. At the end of the process, they showed interest in knowing more about animals, especially the wild ones. They also considered the game as a tool to increase animal skills such as speed, dexterity, and development of smell. These perceptions highlight several aspects of design and games: the importance of involving animals as part of the design process; the potential games have for learning; a potential to empathy sensitization by the stimulus of perspective-taking, reflection and relationship-building.

In another project, Hanna Wirman (2014) conducted an exploratory game design activity with two orangutans at a rescue and rehabilitation centre in Indonesia. The researcher introduced computer technologies — particularly touchscreen interfaces — and experimented with different games in which the orangutans could perform a set of simple interactions such as moving objects, making items disappear by touching, drawing, selecting and watching videos. Among the objectives of the study were the improvement of the quality of life of orangutans in captivity and the discussion about how games can be used as a way of facilitating interspecies interaction.

Although physical similarities between orangutans and humans suggested a human-like interaction experience, Wirman's studies revealed limitations of such a pre-conception in at least four aspects: input mechanisms, as games were not designed to respond to the modes of interaction used by animals, such as the palm of the hands, wrist, licks, legs, feet and applied force; viewing angle, as the orangutans may interact too closely or too far from the screen, or upside down, and the interaction was generally dispersed; software/hardware, as the screens were licked, touched and often destroyed; and continuum of play practices, as the animals' interaction with technology was always competing with other forms of play, and in general, could not be determined when one game started and another ended.

Fig. 2.
Orangutan using index finger to interact with a touchscreen device (left) and observing an orangutan-proof touch screen 'too close' with his keeper (right).

4 THE NONHUMAN TURN: NOTES TOWARD THE EXPANSION OF THE INTERACTION DESIGN FIELD

The integration of nonhuman animals as participants in the design process places a series of challenges and constraints to the field of interaction design. In the context of designing playful nonhuman-centred experiences that we propose, interaction design emerges as a potential field to be explored. This scenario exposes opportunities for developing theoretical, technical, methodological, ethical, affective, technological aspects of the practice of interaction design itself.

Despite being multidisciplinary, the methods of interaction design are largely human-focused. The question that arises here is then whether this is a practicable approach when dealing with nonhumans? Zamansky argues that in order for Human-Computer Interaction methods "to be usefully applied, it is important that animals are enabled to express their needs and wants; this implies not only the possibility of freely providing feedback to what human designers might propose, but also crucially the possibility of 'suggesting' design solutions of their own" (2017). Accepting animals as creative agents in the design process, offers new possibilities for communicational interactions (Jorgensen and Wirman 2016).

As Pons and her colleagues (2015) point, studies with humans generally rely on verbal or written communication. These are the main ways for giving instructions and gathering informational feedback about the systems being evaluated. Because of these limitations, some researchers claim that animals do not qualify as research participants (Resner 2001), or even that it is not possible to involve them in the design process (Lawson et al. 2016). The impossibility of verbal or written communication with animals demands new ways of literacy that may potentially build new communicative bridges among species.

Dealing with non-verbal communication is already part of the interaction design practice. Cross (2006) argues that non-verbal communication is used during the creative thinking process as well as aids to communicating ideas and instructions to others. In addition to that, designers manipulate non-verbal communication as they translate abstract requirements into concrete objects. One of the ways to apprehend these codes is through observation. Designers are therefore specialists in watching what people do (and do not do) and listening to what they say (and do not say) (Brown 2009).

In favour of a nonhuman approach, Westerlaken and Gualeni (2016) explore the notion of "becoming with" (Haraway 2008) as a way to achieve some non-verbal mutual understanding. The authors suggest taking part in the playful interactions and explore the possibilities together with the animal rather than observing them and their interaction. The integration of nonhuman animals as participants in the design process has the potential to change the designer's own ideas and point of views. In this context, empathy becomes a potential approach for learning the languages of nonhumans.

To empathize with animals involves recognizing that they have the ability to feel, perceive, experience subjectivity, but without expecting that their experiences are similar to humans'. An empathetic connection suggests predisposition and an open-minded posture for it to occur. As Wirman (2014), the lead researcher of the study with orangutans presented on the previous section, said: "Sometimes, I assume, I have been trying to teach them to be what they cannot be. This has occasionally led to feelings of great incompetency, which I am little by little learning to let go and allow control from my side to theirs". And adds: "If I had taken the route to really teach (read: condition) the apes to 'correctly' use and play the games I made, this would have been a step away from my very understanding of play itself".

The interaction with technologies does not always involve humans. Animals engage in computer interactions in farms, research laboratories or open fields on a daily basis and may be a user base for interaction designers to engage with and potentially improve the processes and living conditions of those nonhuman individuals (Mancini 2011, 2013). Machine learning algorithms and computer vision techniques, for example, are being explored as a way to distinguish locations and body postures of animals (Pons et al. 2016). Those technologies seem to be more efficient since they are less invasive for the animal than wearable devices, such as collars with attached gyroscopes and accelerometers (Ladha et al. 2013) or even IR emitters (Bozkurt 2014). Furthermore, projects like this have the potential to bring useful insights for the possible observation and identification of playful behaviour and signs.

It is not new that humans have been studied as part of a biological continuum. Mancini (2013) argues that biologists seek "to better understand human cognition and emotions by comparison to those of other species". Understanding animal behaviors and nonhuman applications may benefit both humans and interaction design in return. The knowledge coming from understanding insects' behavior, for example, has been impacting design practices and technologies of areas like artificial intelligence and robotics (Parikka 2010). Rover@Home (Resner 2001), a remote human-dog interaction system for training, could be used by remotely located parents to teach pre-verbal children. Moreover, tablets and fixed screen interfaces are continuously used in a research program on language acquisition by nonhuman species (Schweller 2012). Those kinds of studies, as Mancini (2013) points out, may trigger insights for designing and improving interfaces to, for example, "help pre-verbal or dyslexic children learn language".

Designers know how to explore existing traditions, practices, and goals, and by a movement of framing and reframing social activities and contexts, know how to come up with innovative solutions (Murray 2012). This movement applied to interaction design positions the field before a movement towards its own expansion as an approach to the connection with the nonhuman world. With this paper we intended to reflect on this, raising awareness and sparking debate about studying interspecies interaction. This approach is, in a way, a political act, an attitude to look at interaction design as an effort towards interspecies ecologies.

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Artistic Assemblage

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This paper refers to the theories of Extended Mind (EM) and enactivism as cognitive frameworks to understand contemporary approaches to art practice. The essay is structured in four sections and offers examples from existing works of artists across a range of media, with a focus on the computational arts. Initially, we compare the two models of cognition by highlighting differences and similarities, arguing that the epistemic value of each approach is observer-dependent. Following, we explain why art can be considered as a form of language. Then, we echo from the concept of "assemblage" as a mode of thinking (Dewsbury, 2011) expressed in Deleuze and Guattari (1987) and more recently in Hayles (2017) by proposing the idea of the "artistic assemblage". In the end, we underline the validity of both cognitive models for understanding the system of relations, which allows the emergence of the "artistic assemblage".

1 INTRODUCTION

The last thirty years have witnessed a radical transformation in cognitive sciences that initiated new interpretations of human mind as the subject of cognition. The relevance of language as a cognitive device has been discussed by authors such as Lakoff and Johnson (1980) already in the early eighties. The intuition that metaphors actively influence our cognition through the structures of language by gathering information from the surrounding environment was one of the earlier gateways towards a new perspective in cognitive sciences. However, it was the idea of enactivism proposed by Varela, Rosch and Thompson (1992) and, a few years later, the concept of Extended Mind (EM) by Chalmers and Clark (1998), that unlocked the traditional paradigm of cognitivism, up to that moment aligned with the computational theory of mind. This new approach shifted the focus of cognition from the physical system of the brain, making the environment and the body as active parts of the cognitive process.

This paper examines how these theories influenced the arts today by referring to existing artists and their works, with a particular attention to the computational arts. The evolution and diffusion of the computational arts are a reflection of a transformed environment in which technology becomes transparent and more integrated with it. The possibilities offered by augmented perception have produced an outburst of artists proposing new ways for interpreting or playing with reality, new ways of experiencing the self and the world around us.

People like Zachary Lieberman and Golan Levin, for instance, mix coding and performative arts, but also the activists/artists Neil Harbisson and Moon Ribas, founders of the Cyborg foundation, are examples of how the theory of the EM and enactivism contributed, perhaps indirectly, to influence the contemporary art practice worldwide.

This work consists of four sections. The first part will briefly outline the differences and similarities of enactivism and the theory of EM. Then, it will juxtapose art, in this context considered as a language (Leroi-Gourhan, 1993, Manning and Massumi, 2014), with the extended mind, proposed also as a language by Clark (1998). Further, we argue the importance of technology as a tool to convey a language and therefore, to make art. By drawing from the works of philosophers such as Leroi-Gourhan, Simondon, Deleuze and Guattari we offer an alternative point of view to think about art making, introducing the concept of “artistic assemblage”. In the last part, we explore new pathways in cognitive sciences with authors such as Erin Manning, Brian Massumi and Katherine Hayles by linking their views to contemporary art works of artists such as the philosopher and painter Bracha Ettinger or the computational artist Lauren McCarthy. Eventually, we discuss the role of the self and its modalities in the “artistic assemblage”, underlining the differences between the two cognitive approaches.

The aim of this work is not engaging with the technical aspects of EM discussed in Clark (1998) or the spiritual implications of enactivism outlined in Varela, Rosch and Thompson (1992). Neither to expand about the concepts borrowed from the philosophers taken into account. Rather, its goal is to focus on computational and traditional art practice by presenting how two different perspectives offer equally valid approaches for experiencing reality and for expressing the (augmented) self.

2 COGNITION DOESN'T HAPPEN IN THE BRAIN

Enactivism and EM can be grouped under the umbrella of 4E cognition (Menary, 2010) however, it is important outlining both the differences and the similarities of these two concepts, in order to understand the potential contribution that each approach is bringing to art practice nowadays. Chalmers and Clark (1998) and Clark (2011), talk about the theory of the extended mind as a system that moves on a Cartesian basis. The EM assumption considers the environment as extension of the subject of cognition (a human being) and preserves a dualistic coordination. In fact, EM is described more as a coupling rather than a full integration of the elements. In EM framework, the environment becomes a device: an appendix that augments the cognitive abilities of the subject. On the other hand, the theories of enactivism tend to focus on the body and encapsulate the milieu in the cognitive apparatus, merging the two elements in a new entity, which is not just the sum of the parts but is to be intended as ecology (Manning, 2013). In this sense, the subject and the object of cognition are intertwined and the system is considered as a whole.

Despite the criticism (Clark and Eilan, 2006; Clark, 2011) to the sensory-motor dependency proposed in enactive models (O'Regan and Noë,2001; Noë, 2004) one important common point to both perspectives is ruling out that cognition happens exclusively in the brain. For both, cognition is part of a more complex structure that can involve the individual, the milieu – *intérierur, exterieur and technique* (Leroi-Gourhan, 2012) the perceptive mechanisms, the consciousness, and the idea of the self. Furthermore in both cases, this new organisation is flexible and adapts to circumstances.

Having considered the above premises, it may be argued that merging the human with the environment rather than coupling them, it would be just an epistemic choice made by the observer. Accordingly, this will affect how the cognitive apparatus perceives the whole system. More specifically, that choice will influence the type of information received before becoming cognition.

To understand the difference between the two theories we draw from the concepts of "becoming" (Deleuze and Guattari, 1987) and "transduction" (Simondon, 1992) applied to the human subject and the environment. The force created by their dynamic represents also the figurative space (as well as the time) in which the "difference" (Deleuze, 1994) takes place, not just by defining the new assemblage but by outlining the conceptual and cognitive diversities. In other words, the gap between the two approaches is very dependent on the way the subject is integrated into the environment, but this involves the presence of an observer that in our case can be the actor him/herself.

2.1 A system of relations

To explain further, we can think of a sand dune. When we look at it, we see a mass of dirt and we consider that as a single “object”. If we shift our perception, we start seeing that mound of sand as actually made of grains. Each grain looks identical and separated from each other, however it preserves the ontological properties of the sand and therefore it is not “less sand” to us than the whole dune. Then, if we use a microscope and observe the sand, we realise that each grain is actually very different and it looks like a small stone or a shell. Therefore, the difference between the scaled grain and the dune exists only in a perceptive domain. At the same way, if we observe any complex aggregate, for instance a neighbourhood, a city or even our entire planet, from a higher viewpoint, we will not be able to distinguish the separations between the single elements and we will end up considering the system as a whole.

But it is also possible to consider this from the opposite viewpoint. When we look at the individual parts of the system, we are actually observing a system of relations, where the separation between the elements is very dependent on our understanding of the concept of unity. Where do these considerations lead us? For this reason, we can assume that the separation between the subject and its milieu is just perceptual and is very dependent on the focus of the observer, therefore it is functional.

The relation between the subject and the environment is a topic largely explored in philosophy and psychology on consciousness, perception, reality and causality. Here, we mainly refer to the concept of “entrainment” expressed in Manning and Massumi (2013) borrowed from Michotte (1963) and inspired by the concept of “causal efficacy” (Whitehead, 1927-28).

The description of how the subject entangles with the environment in Manning and Massumi (2013) resonates with a more metaphysical conception of “becoming” as expressed in Whitehead (1927-28). Despite Whitehead’s position on the non-continuity and multiplicity of the becoming, in opposition with Deleuze’s monism, the common vision is the importance of a system of relations consistent with a rejection of the mind-body dualism (Shaviro, 2009).

> “In this way a group of actual entities contributes to the satisfaction as one extensive whole. [...] By reason of vagueness, many count as one, and are subject to indefinite possibilities into such multifold unities (Whitehead, N., 1978, p. 112).

The ability of our cognition to detach parts of the whole from the background is not only a philosophical speculation. In fact, there is evidence that similar dynamics seem to be embedded also in our biological conformation. For instance, the Gestalt psychology empirically tested how our visual perception of unity works (Kohler,1947).

Despite the conceptual differences between EM and enactive approaches, at present, a considerable number of works in computational and contemporary art practice can be interpreted through the lens of these two theories. This essay describes the shift from one approach to the other by considering artists and art works that, in our vision, cross the boundaries of the two models.

2.2 Artist and machine integration

Tempt One is a graffiti artist who highly influenced the Los Angeles graffiti culture in the eighties. In 2003 he was diagnosed with ALS (Amyotrophic Lateral Sclerosis) and today his whole body cannot move apart from his eyes. Around 2008-9, artists from Free Art and Technology (FAT), OpenFrameworks, the Graffiti Research Lab and The Ebeling Group, collaborated on the making of an eye-tracking device that could allow Tempt One to continue his art. Noticeable artists amongst them were Zachary Lieberman, Evan Roth, Chris Sugrue and Theo Watson. The large documentation online about this opensource device and the progress made by the community shows how, in a few years, the graffiti artist was able to "tag"[1] again with the use of an external device.

The first attempts of the artist to use the software resulted in very simple drawings. However, by following Tempt One's feedback, the developers of *"The EyeWriter"* managed to customise the software and the hardware according to the user's needs. At the same time, Tempt One adapted his skills to the device's possibilities and eventually, the practice allowed him to integrate the tool at such a deep level that now it can be considered as the artist's body extension, with a consequent improvement of the artistic results (The Eyewriter, 2010).

Another example is Neil Harbisson, a contemporary British artist born with a severe form of colour blindness called "achromatopsia" that doesn't allow him to see colours other than black, white and greyscale. This impairment was the trigger for him to build a device able to translate colours into sounds. A small microchip detects the visual spectrum properties of the objects around him and translates that into a sound frequency, which is perceived as a note: the higher the colour frequency, the higher the note.

In the prototype device, called "*Eyeborg*", Harbisson could hear the sound through headphones. In this way, he was enabled to synesthetically "listen" to the colours around him and compensate for his dysfunction. Besides, Harbisson uses his augmented sensoriality in art pieces where he visually represents, for instance, Beethoven or Vivaldi music (*Colour Scores series*) or create a series of *"Sound Portraits"* of famous personalities such as Steve Reich, Philip Glass, Woody Allen among the others. He named this type of art "sonochromatism", which stands for union between sound (from Latin "sono") and colour (from Greek "chromat") (Solon, 2013 and Jeffreys, 2014).

The cases of Harbisson and Tempt One have strong similarities with Otto, the patient with Alzheimer's mentioned in Chalmers and Clark (1998).

1. From Oxford dictionary: informal A nickname or other identifying mark written as the signature of a graffiti artist. [Online] http://www.oxforddictionaries.com [Accessed 18 December 2018]

All the three men lack a structural function that is counterbalanced by an external device. Tempt One's eye-tracker, Harbisson's bionic eye and Otto's block note accomplish the same role of backup.

However, Neil Harbisson's experience differs from Tempt One's and opens up to a more substantial interpretation. In fact, following the first experimental technical trials, new and more sophisticated versions of the "Eyborg" were produced. Harbisson decided to physically integrate the device into his body by implanting a chip into his cranium. The device so constructed, was able to capture the colours and conduct the sound directly through the bones of the artist. In this scenario, the two theories of EM and enactivism overlap and start blurring. By doing so, Neil Harbisson is not only the personification of the archetypical extended mind-subject. In fact, by merging with the technical milieu, he also moves into the limits of what we can consider enactivism. Harbisson doesn't consider his antenna anymore as a simple extension of his body, he believes it to "be" his body as much as a normal eye. The artist claims he showers with it and goes to sleep with it and, as a result of this prolonged altered experience, his brain's neural network physically changed. The new cognitive entity (human and technical device) now behaves as an ecosystem that has implications in the larger social environment in which the artist lives. Eventually, his strong belief, led him to a politic activism with the goal of being recognised as a cyborg by the British government and having his antenna showing in his passport picture (The Cyborg foundation, 2015).

Despite the fact that the artists deliberately may, or may not, have taken inspiration from these philosophies, the examples above demonstrate how complex, yet powerful, these theories can be when applied to art practice. The emergence of these theories radically affected the way we look at the world and this is subsequently shaping society. Art is supposed to draw from it and express this transformation through practice. The possibilities offered by exploring the meaning of an augmented cognition are disparate and multiple. Among them, there is undoubtedly the possibility for an enhanced language.

3 ART AS A LANGUAGE

We live in a multilayered and complex reality and we constantly try to make sense of it. Our perception of reality is influenced by an array of factors such as physical and genetic structure or social background and personal beliefs. On the other hand, there is evidence of human beings' ability to represent reality through symbols at least since the Paleolithic, possible indication that this skill is hard-wired in our biology (Dyssanayake, 2001; Davies, 2012). A shared theory is that they were the first attempt to make art (Bateson, 1972).

Furthermore, Leroi-Gourhan (1993) noticed that primitive art is a system of symbols somehow representing reality through transposition rather than mimicry. He debated that one of the reasons for this primordial human activity was the need of our ancestors to communicate within the community but more importantly the need to understand reality and thus, knowing their own selves. Therefore, the ability to create symbols and to make sense of them generates a recursive system in which one enhances and influences the other. Besides, glyphs and graffiti were compared much more to a written language than art (Leroi-Gourhan, 1993). Nevertheless, it is generally accepted that symbolic communication is strongly related to cognition and both are deeply rooted in the history of human evolution.

In the article "The Extended Mind" by Andy Clark and David Chalmers, the authors introduce the idea of language as extended mind. Like a fish is a "swimming device" able to create vortices of water around itself to improve its speed and facilitate its movement, so we are, swimming devices in a "sea of words"(Clark and Chalmers, 2002). Constantly immersed in a rich linguistic environment since birth, we developed a system able to shape our thoughts accordingly. The language to which the authors refer doesn't necessarily have to be limited to spoken ones. In this framework, the language should be intended as the carrier of cognition, that is, a link between the cognitive agents. With the above premises, if it is considered valid that language and art share the same origins and the same nature of symbolic transposition of reality, we may suggest further to consider art itself as a language, therefore as an extended mind.

3.1 Between the artists and the performance

In the work *"Messa di Voce"* (translated from Italian "placing the voice") the artists Golan Levin (2003) and Zachary Lieberman (Levin and Lieberman, 2004) created a set to be performed by two vocal improvisers. The whole work draws on the concept of abstract communication and language by using custom-built technology that reacts to the performers' voices. The show can be seen and read on two levels. On one hand, Levin and Zacherman are the "dei ex machina" whereas the actors Jaap Blonk and Joan La Barbara, entirely enclosed within the piece, become the extended minds of the two artists, performing their work through them. The performers embody the potentiality of the software written by Levin and Zacherman and become themselves an expressive tool completely implemented and necessary to the assemblage. On the other hand, in a sort of "Chinese boxes" structure, Blonk and La Barbara deal with the digital artefacts and design a story using an augmented language. The audience, together with the actors, are engaged in a synesthetic experience and the outcome is strictly dependent on the interaction created by this new cognitive body. The players produce their work while becoming the work, at the same way the fish generates the vortices by moving its tail.

However, an alternative interpretation could be the enactivist one. The concept of real-time and interaction are cardinal in *"Messa di Voce"* as well as in the enactivism expressed in Manning (2013) and Manning and Massumi (2014). The two actors are producing and at the same time experiencing the performance, altering the visuals with their voices and body, becoming themselves each time a moving ribbon, a set of particles and blobs or a flickering shape. They override the division between the action and the visual output by using the voice as a bridge for the expression. The graphics produced by their voices create a reactive environment, which will reciprocally affect the way the actors behave. There will be one moment in which they will move from "acting" into "being" the performance. Not only will they express themselves with their voices, they will become a new entity merged with their physical body and the visuals.

The same concept of vagueness can be found in *"Transcranial"* realised by the choreographer Klaus Obermaier, together with the software artists Kyle McDonald and Daito Manabe. The performance is an experimental choreography that puts on stage a conversation between the parts of the human body and the face. In the first act the performer is connected to magnetic stimulators that affect his facial expressions. In the second act, the dancer's moves are digested by the custom software and ejected in a brand new kinetic form. The code "becomes" the voice enacted by the machine. As a matter of fact, according to Obermaier, the machine and the software are considered as actors, for it is neither the computer nor the performer to control the other but it is the interrelation between the subjects which alters the dynamic and creates the dialogue (Visnjic, 2014; Obermaier, Manabe and McDonald, 2014).

Once again, it seems that the "difference" between the two interpretations can be found in the focus the observer – either external or the actors themselves – puts on the perceptual approach, in other words in the "becoming". As Manning (2013) suggests in her work about the synesthetic way neurodiversity accesses information, the challenge is to create the settings for the whole work to operate in an "ecology of relations" which could open up new pathways for expressive opportunities. In this vision, computers and software, but in a larger sense any technical object, may become active or even an independent part of a creative process.

4 ARTISTIC ASSEMBLAGE

A few years ago, the British artist David Hockney (2001) reopened the discussion on the theory according to which famous artists such as Caravaggio or Jan van Eyck were using optical devices like the camera obscura or the camera lucida, to facilitate and improve the realism in their paintings. Besides, in a more recent interview (Ganguli and Auksas, 2015), Hockney talks about tools like brushes, pens and pencils as technology. Hockney compares the brush to the iPad and despite the opinion of some art critics, he doesn't see a separation between these two technical tools. In fact, he considers the new works he made with the tablet as a natural evolution of his previous production. Therefore, he does not recognise them as "less art" than his previous paintings (Miller, 2014).

This may fall into the frame of what Simondon (1958) theorised: the brush and the iPad may share the same "genesis" despite their "individuality". Therefore the iPad can be considered nothing but the concretisation of the "abstract technical object", which is the brush. The fact that a brush is considered nowadays “the” tool for painting while the iPad has yet to be considered as such, it is therefore a cultural construct.

Similarly, if we compare a pair of glasses, used to adjust the eyesight, to a camera lucida, which is a tool that extends the abilities of the human vision, we realise that the spectacles may be considered as the abstraction of a camera lucida. In this direction, Pablo Garcia and Golan Levin (2014) produced a contemporary version of the old device, the “*NeoLucida*”. This is interesting not only because it is an opensource and crowdfunded project but also because it is a technical tool made by artists, with the aim of demystifying the action of drawing as a “superhuman” ability in favour of assistive technology in art practice.

On the same subject of visual perception, the work “Kaleidoscopic Vision” by Moon Ribas explores the possibilities of extended sensoriality. The Catalan performer and dancer, co-founder with Neil Harbisson of “The Cyborg Foundation”, wore a pair of kaleidoscopic goggles for few months and travelled around Europe without seeing anything but a combination of colours with no shape. This experiment, she reports, affected her way of relating to the surrounding space. It also re-organised her ability of relating colours with each other (Solon, 2013). According to the EM model, in this last example, the device is used to expand the artist’s vision. On the other hand, the interpretation of the vision as “something we do” (O’Regan and Noë, 2001; Noë, 2004) may suggest that this can be framed also as enactivism:

> “ Visual perception can now be understood as the activity of exploring the environment in ways mediated by knowledge of the relevant sensorimotor contingencies. And to be a visual perceiver is, thus, to be capable of exercising mastery of vision-related rules of sensorimotor contingency (O’Regan and Noë, 2001, p. 943).

From this perspective, thus, the camera lucida and the kaleidoscope goggles are alike to be considered as an extended vision of the artist, rather than simple tools. Similarly, the brush or the iPad become something more than an extended arm, or hand. The brush merges with the artist and becomes the “enaction” (Manning, 2013) of the artist’s thought.

Moreover, from a cognitive point of view, in all the three examples, the encounter between the human being and the technical object can also be considered as a “machinic assemblage” (Deleuze and Guattari 1987), enacting a new space of articulation and expression. In fact, there is no longer I and technology but an ecological understanding that is nor human, nor technical but something new, yet to be defined. The union of the elements creates a new cognitive agent, which, in two cases enables the artists to augment their perceptive capabilities (*Kaleidoscopic Vision* and *NeoLucida*), in the other extends their expressive efficiency (iPad, brush). Therefore, the EM and the enactivist approaches offer two interpretations that we can consider as “modes of existence” of the “machinic assemblage” itself.

Nonetheless, this conceptual framework takes into account the artist and the tool but excludes the work of art as well as the action of art making from the assemblage. On the other hand, previously we proposed that art, as a form of language, could be considered also as an extended mind and in this sense, entangled with the artist. Therefore, the proposition that can be made now is to consider art (in the making as well as a product) as a coherent part of the machinic assemblage described above. In this new modality, the action of making art represents the agency of the machinic assemblage, more specifically, it becomes the expression of what we can define as "artistic assemblage".

5 FROM MODE OF EXISTENCE TO MODE OF AWARENESS. A FLUID SELF EMERGES.

In opposition to the idea of unity of consciousness, sustained by philosophers from Kant (1781/87) to Bayne and Chalmers (2003), Jackendoff (1987) has suggested an alternative approach. Jackendoff interpretation of consciousness appears to be fragmented as it relies on different sources and presents itself as a multilayered system. However, according to the philosopher, cognition is strictly connected to consciousness, despite the disunity. Jackendoff extends the Cartesian duality of the body-mind a further step, establishing a relation between the phenomenological mind and the computational mind. The former is the mind of experience that deals with the world of phenomena. It is the mind connected to the senses and the outside world. The latter is the mind of reasoning, the computational part of the system, linked to the logical processes.

Although Jackendoff's assumption reduces the consciousness to a projection of the computational mind, he introduces into the debate of cognitivism the concept called the "mind-mind problem". The question that this theory tries to answer is what kind of relation exists between the phenomenological and the computational mind. In other words, how do the world of experience and reasoning work together in order to create the idea of the self?

Without inquiring into the dialectic between single-track and multi-track theories of consciousness (O'Brien and Opie, 1998; Zeki, 2003), we think Jackendoff's view offers a strong interface to understand further possibilities that an amplified sensoriality and augmented awareness could bring to the progress of art practice. In short, a framework where consciousness emerges from the relation between a phenomenological and a computational mind may be particularly functional when the "artistic assemblage" contains a computational element.

5.1 Cognitive actors

We can argue that whenever the self amplifies itself, cognition is strongly enriched. Let us consider, for instance, the Lisa Park performance for brainwaves called *"Euonia"* (Park, 2013 and Olivia, 2014). Her work can be considered as a modern interpretation of the seminal piece by Alvin Lucier, "*Music for solo performer*" (1965). However, in "Euonia", the computational element is extended in the digital and algorithmic domain. With the support of a wearable device, the performer is able to control sound waves generated by her cerebral activity. Custom-built software translates the EEG (Electroencephalography) signal into sound, which is later visualised through cymatics on water surface. In this case the extended self is able to radically affect the surrounding environment, which rebounds into the perceptive mechanism, altering and augmenting the cognitive experience. In this performance, the involvement of the human body is limited to the brain activity and to its reaction to sounds, which indirectly generates in a feedback loop. The actor somehow merges, almost vanishes in the background and “becomes” sound.

This interpretation may also attune with ideas presented by Erin Manning and Brian Massumi. For Manning (2013) the self is not a contained individuality but has to be intended as a folding entity, a fluid modality where the system of relationship is pivotal. The importance of the milieu is central, for the artist becomes the work of art and transforms into an autopoietic organism: the painter becomes the painting, painted by this new “body”.

In “Always more than One” she analyses some of the paintings by Bracha Ettinger who focuses on the synchronicity between the act and the thought. Massumi and Manning (2014) explain that painting for Ettinger is not about seeing, it is about relating forces and fields. It is the intercommunication between the “outside” and the “inside”. It is about “feeling in the making” and “thought in the feeling”. In Ettinger’s painting *Autistwork n2* the artist’s performance turns into a continuous folding of events, a complete synesthetic experience. Furthermore Manning emphasises the role of the rhythm as expression of the multiplicity of temporality, which is also essential for the “becoming” of this new “mode of existence” of what we called “artistic assemblage”.

On the other hand, in the book “Hackers and Painters” the author Paul Graham (2004) equates the painting and the coding, since both are made by “makers”. He underlines the analogies of these two actions. According to his experience as a painter and a programmer, the approach to the act of painting and to hacking is comparable. His opinion recalls Hockney’s statement about comparing a traditional technical object like a brush to a computational technical tool such as software.

However, an opposite view has been suggested by Katherine Hayles (2015). She proposes that technical tools such as a hammer (or in our case a brush) and an algorithm have a substantial difference that extends in the domain of cognition and consciousness. Hayles’ broader definition of cognition focuses on the ability of the subject to *interpret* and *choose*, common to biological and technical tools like algorithms. Hayles explains further, that “nonconscious cognition” can happen before the thinking, can be independent from consciousness and can be located either in the individual or in the whole system. These conscious/unconscious “modes of awareness”, to use her words, can only happen in a system of relations and it is essential in the formation of the self. Furthermore, she argues that the “unconscious awareness” is a prerogative of a living system or something that behaves like one, indeed an algorithm. Tools like financial or genetic algorithms manifest an “intention towards”, a task which in the case of a biological organism like a bee, to use Hayles' example, is the protection of the beehive, whereas in artificial intelligence is the progression to a more efficient generation. In this sense, algorithms and technical "cognizers" are elevated from simple "agents" to cognitive "actors". This technical ecosystem entangles with the biological one made of humans and animals, in a more complex apparatus defined "cognitive nonconscious assemblage" (Hayles, 2017).

5.2 Equilibrium between the modes of awareness

How tools like software and algorithms alter our cognitive apparatus, is a subject explored in particular by computational artists. For instance, Lauren McCarthy is an emerging artist and programmer interested in the relations between social interactions and technology. Her works range from Internet art to performances and there is particular attention to the way algorithms and automation influence our everyday life. *"Social Turkers"* (McCarthy, 2013) and *"PplKpr"* (McCarthy and McDonald, 2015) are two interesting examples of how augmented cognition can affect our relations with other people.

In *"Social Turkers"* McCarthy dated some people contacted using a dating mobile app. With the help of her smartphone, she streamed in real-time every meeting to an audience hired on "Amazon mechanical Turk" which offers an on-demand workforce. The observer group was paid to make comments about the date via text message, which would eventually affect the social interaction during the meeting.

The other work is "*PplKpr"*, a mobile app that, connected to a wearable device, allows the user to filter social relations according to his/her biological response. Every time the user meets someone, the app will track and record the physical and emotional reactions and will accordingly propose, for instance, to meet again, to cut the conversation maybe, or to avoid this person in the future.

Both works are provocative and engage with the idea of the self-awareness and the relation with the "other". In particular, the artist criticizes the way automation and algorithms are influencing our decision-making abilities and therefore transforming the idea of the own self. Which one is the decisional agent if the nonconscious cognition is influenced by an algorithm? How can we (re)define agency in this context?

When we consider Bracha Ettinger, we have no doubt that the new system "painter plus painting", or "painter plus brush" will live in an autonomous ecology, depending mostly on her ability to merge into the background and "become" action. On the other hand, whenever we introduce a computational actor, such as software or an algorithm, the new extended entity depends on the equilibrium between two potentially nonconscious "modes of awareness". The substantial difference is that a brush will, very unlikely, be able to make any decision, whereas an algorithm may be. This alternate decisional process between human and technical actors recalls what Hayles (2017) defines as "punctuated agency".

The considerations above expressed may suggest that some differences exist. However whether the self extends to any external device or merges with the milieu, it brings to the cognitive process a whole new synergy for the "artistic assemblage". This consists not only in the nature of the technical object or of the environment's characteristics but also in the embedded expressive potential of each element of the assemblage, despite their mode of awareness.

In this perspective, we can argue that the cognitive modality of an "artistic assemblage" can also help in reducing the risk of separation between human creator and human audience, in works of art created with artificial autonomous systems, as explained in Daniele and Song (2019). Experiencing the art making as agency of the artistic assemblage would give the cognitive co-existence (human plus technical) a new equilibrium.

6 CONCLUSION

Today the boundaries of art, science, social sciences, psychology and philosophy often overlap. Sometimes these fields of study merge or communicate with each other like in a homeostatic organism. Therefore, when we discuss one of these disciplines, we indirectly implicate the others. Many artists do not come from a traditional fine arts setting. They may approach art from very diverse backgrounds like, computer science, psychology or philosophy.

The implications of this combination have echoes in many fields. By applying their creativity, artists cross the borders of medicine or technology for instance, solving physical impediments like in Neil Harbisson and in Tempt One's cases. In other circumstances they offer an alternative perspective for neurological diversities like the enactivism seen by Manning and Massumi.

The experiences presented in this work are a small sample of an ongoing activity in the field of the arts that explores augmented awareness. By undertaking the approach of a not "brainbounded" (Clark, 2011) mode of existence, the possibilities for the artist's creative process extend towards something as yet unknown. Whether art emerges as a language, as an extended mind or as "artistic assemblage", it will decisively expand the individual's and subsequently the collective cognition.

From what we discussed, what may open up for further research in the field of arts and science is the "difference" between nonconscious modalities. The interplay between biological organisms like human beings with algorithms, for instance, or autonomous machines, can create a system of relations that may spring unpredictable outcomes between conscious and nonconscious modes of awareness. Nonconscious modalities in art practice, combined with an augmented cognition could unleash a set of creative possibilities, for none of the actors (biological and technical) will be able to predict the exact outcome. In this way the act of producing art will get closer to some form of improvisation and will have to rely highly on intuition. As expressed in Bateson (1972, p. 147)

> Art becomes, in this sense, an exercise in communicating about the species of nonconsciousness

Finally, what seems to be mutual among the cognitive models described above is the importance of a system of relations in which the “difference” between the elements in the systems, works as the “transducer”, allowing the “becoming” of the new cognitive assemblage.

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Aesthetics of Uncertainty

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Machine learning has a tendency to reveal inconsistencies which have transversal relevance bridging computer science with art and the humanities. Rather than purely situations of inconsistency, discrepancy, or malfunction, Derrida's notion of aporia (Derrida 1993) describes uncertainty as a precondition of dialectics. Expanding on Derrida's line of thinking, this paper speculates that the internal frictions which can be found in artificial intelligence and machine learning systems may be understood in terms of a new kind of aesthetic informed by uncertainty.

1 INTRODUCTION

The cold calculation of computational processes may appear the epitome of certitude, yet there is an internal discord between the level of uncertainty in machine learning and its probabilistic approach (Pasquinelli 2019). While computation is itself deterministic, executing mathematical procedures, machine learning is a non-deterministic approach capable of producing unpredictable outcomes (Lehman et al. 2018). The tension between the certainty and uncertainty in machine learning divulges an aporetic sense of the uncanny (Freud 2003) in the process. The incongruity which arises in the outcomes of machine learning prompt a need for interpretation much closer to the humanistic approach of hermeneutics than the norms of computer science. Derrida argues that the exercise of freedom is predicated on aporia: moments of impasse, doubt and contradiction, which open up the imperative to act, to decide, to reason. Applying Derrida's line of thinking to the situations of aporia presented by machine learning, this paper speculates as to whether the indeterminacy entailed in the use of machine learning systems may contribute to an aesthetics of uncertainty. Developing this notion from the interplay between the predictive intentions of machine learning and the unpredictability at work in its use, this investigation asks how uncertainty may present itself as a guiding principle of aesthetic applications of machine learning.

2 UNCANNY MACHINERY

What one apprehends in machine learning-generated images is often a visualisation out of uncertainty. Looking closely at several such examples, this section develops an understanding of several aspects of uncertainty in machine learning and artificial intelligence.

2.1 A Face Which Resembles No One

Situations of uncertainty within content generated using machine learning are often accompanied by an element of the uncanny, a sense of indecision as to what to make of what one is experiencing. This first, intuitive sign of uncertainty signals an unresolved contradiction within the process. In computer vision systems, this often arises in the form of discrepancies between the particularities of human vision and visual processes performed by computers. For example, eigenpictures, introduced by Sirovich and Kirby in 1987, are images representing a set of basis features in a data set of images. Initially applied to recognition of faces, hence the term "eigenfaces", this approach entails performing principle component analysis on a dataset in order to reduce the amount of information necessary to perform facial identification. Generating a smaller set of images representing the most salient features in the dataset, eigenfaces facilitate facial recognition by creating a set of average images against which to compare inputs. Invoking the prefix, "eigen-", meaning "own" or "proper", in this case is itself fairly conflicted. It appears to conflate instantiations of faces with their salient parts. To claim an eigenface as one's own face or one's proper face would be difficult. Yet while an eigenface may appear blurry and imprecise to human viewers, it is nonetheless mathematically representative of part of an image dataset. For this reason, eigenfaces manifest a visible contradiction. Although they are reminiscent of the data used to create them, these uncertain images (Ekman et al. 2017) are not so much an "own" face as the condensed aspects of a face as defined from a crowd of other faces. In an eigenface, one encounters a composite face which is not passable as a human face, but which somehow exudes "facelike" qualities. This ghostly apparition arguably contains something of an essence of "faceness", yet an eigenface may conversely elicit a mild reaction of repulsion in viewers: recoiling from a face which resembles no one. Part of this rests on the fact that faces, in all their variability, are not that different from one another. It is paradoxically comforting and disturbing to see in these images that "we", in the grand sense of "humanity", are more similar than we tend to think. The overestimation of visual difference among bodies engrained and propped up by biology, culture and politics are in some senses disregarded by the procedure of producing these average images. But beyond our astonishment at creating a thing which projects a human likeness back at us, it is also horrifying not to find our own face in the looking glass. Am I represented in the dataset? What does an averaged face say about faciality? Have I been ensnared in an apparatus of capture, hooked by the face?

Fig. 1.
Eigenfaces by Jeremy Kun, 2011.

The eigenfaces produced by Jeremy Kun (Fig. 1.) visually pose questions to us, appearing as spectres of personages who emerge from and recede back into the darkness. While not intended themselves to be works of art, these images vacillate between the rationalism of calculation and the nuance of their haunting beauty. While the level of faciality instrumentalised (Parisi 2018) in facial recognition and generation algorithms is significant enough for it to be efficacious, there remains a significant gulf between the characteristics of algorithmically-analysed or generated faces and the representational norms culturally accepted as aesthetically desirable. These are procedural (Carvalhais 2016) faces, intended to be computed, not considered end-products in themselves. Yet the faces produced, even by relatively successful generative adversarial networks (GANs), inspire description as awkward, creepy, eerie, generally uncanny. The discrepancy between our expectations of what a face is or should be and that which is produced using current machine learning techniques grows narrower as machine learning systems become more effective, but as they do, it raises questions as to what is really at stake in such forms of representation. While there is a tendency to take great satisfaction in the failure of machine learning and artificial intelligence to compete with human ability, there are often equal levels of fear and elation when computers succeed in this pursuit. Even beyond the Turing test, there is a persistent inclination to consider the human the measure of machines. This lends itself to an inevitable uncanniness of finding such comparison inconclusive, not least due to the lack of a consistent metric, “human”, against which to compare, but also because at a certain point such measurements don’t return much information. In many ways, the questions posed by the outcomes of machine learning are merely a reflection of the questions posed through the process itself: the design of the methodology is dependent upon on the desired result, rather than the inverse. There is therefore a level of the uncanny in the practice of designing algorithms to replicate human traits before feigning surprise at their human resemblance.

2.2 Imaging Invisible Infrastructures

The uncertainty of machine learning and artificial intelligence also reveals itself in other ways beyond the uncanny discomfort of machinic representations. Uncertainty may also be found at other levels of machine learning systems, such as the degree of unknown factors within the vastness of high-level computational processes. For example, the proposition of apprehending a machine learning system in its entirety is astonishing in its own right. Kate Crawford and Vladan Joler’s *Anatomy of an AI System* (Fig. 2.) takes a comprehensive view of an apparatus which is otherwise far too amorphous, complex and colossal to fathom. What one encounters in using the Amazon Echo, they show, is only the tip of a very large iceberg. It seems the more one digs, the more one finds in excavating the hidden labour, data and planetary resources obscured behind the physical device itself. By taking meticulous account of all factors possible, even and especially those considered “externalities”, it is revealed how expansive a seemingly simple “smart” device is in actuality. It is only through taking an exhaustive perspective as Crawford and Joler do that one can grasp a sense of the monumental scale of such a system.

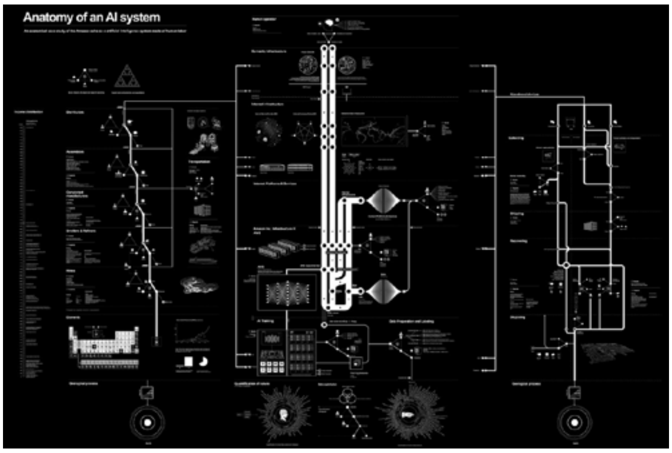

Fig. 2.
Anatomy of an AI System.
Diagram by Kate Crawford and Vladan Joler, 2018.

An especially compelling quality of *Anatomy of an AI System* is its wavering between certainty and uncertainty. On the one hand, it is demystifying in that it lays bare the kind of system that is often talked about in approximations, metaphor, unknowns and unknowables. In accounting for all parts of a seemingly immeasurable network of invisible, obscured or unknown infrastructure, the researchers unmask the beast at the same time as demonstrating its magnitude. The sheer volume of information, in itself clear, gives these diagrams a level of exposed opacity. It's worth noting that sharks are listed among the issues facing the submarine cable infrastructure which forms a part of the immense combined infrastructure behind the Amazon Echo (see Fig. 3.). This is due to electrical disturbances emanated by the undersea cable provoking them to attack the cable. One would hardly suspect from the household gadget's humble appearance that it is engulfed in a much larger assemblage aggravating sharks on the ocean floor, among its many other unforeseen consequences.

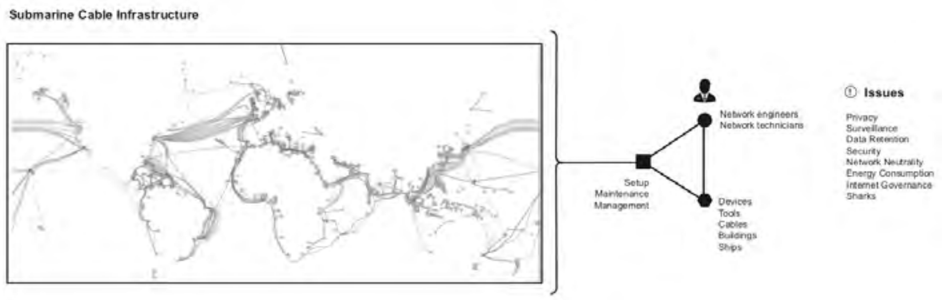

Fig. 3.
Anatomy of an AI System, detail.
Diagram by Kate Crawford and Vladan Joler, 2018.

3 AESTHETICS OF APORIA

The indeterminacy of machine learning systems opens up situations of aporia: moments of irresolution in what are expected to be exact procedures. Derrida describes aporia as a necessary condition for dialectics (Derrida 1993, 14), as it is uncertainty that necessitates decisiveness. Espen Aarseth writes of aporia (Aarseth 1997, 90-96) as a situation of inaccessibility or impasse, which then lends itself to epiphany. I differ as to my interpretation of the term aporia, defining it more in line with Derrida's usage, but I do find Aarseth's approach to reading relevant to the present investigation, as it emphasises that in situations when clarity is lacking, an interpretation must be made. If this is so, and uncertainty is a vital circumstance for the exercise of decision-making, could the uncertainty entailed in machine learning and artificial intelligence be considered productive of openings for aesthetic decision-making? Some of the most entrenched aspects of valuation in the appraisal of art are unsettled by machine learning encroaching into the artistic sphere. The issues of agency, autonomy and synthetic introspection evoked by generative machine learning algorithms act to undermine art world dogma regarding what art is or should be. For example, machine learning art challenges the art object's status as

1. As has been claimed by the group Obvious

singular, individuated, scarce, original: *an object*. It also questions the notion of a work of art being a reflection of the intellect of its author, which in this case would be difficult to identify. Naming the algorithm as the author of an aesthetic artefact[1] fails to grasp the importance of the creation of the systems which in turn produce the artefact. Yet crediting a human or humans alone leaves out the significance machines, and machinic processes, played in the process. In the case of the eigenfaces which were examined previously, not only is there ambiguity in authorship, human, nonhuman or composite, but there is also confusion as to their subject. Eigenfaces are not windows into the interior world of the person whose face stares out at us. Artificially generated faces are not only simulacra (Baudrillard 2010), computational portraits without sitters, but they are practically non-representational. The generated face is a flat approximation of what a human may take to be the face of another human, not a representation of how computers interpret humans to be or to appear (Moura 2017). On the other hand, an artificially generated image bearing a resemblance to a face is no less a depiction of a face than traditional forms of images, such as photography, painting or drawing, which have only tangential relationships with the objects they are meant to depict.

4 CONCLUSIONS

Though often inconclusive and prone to irresolution, one may think of the aporetic openings (Anker 2009) revealed in the creative use of machine learning as contributing to the aesthetic properties of algorithmic media, rather than merely acting as discrepancies within their functionality. In lack of traditional criteria by which to adequately judge the products of machine learning, uncertainty may be viewed as a new conceptual approach to aesthetic qualities of artefacts produced using machine learning. The first example covered in this paper, eigenfaces showing averaged features from datasets of human faces (Kun 2011), offers insight into the ambiguity between the decisiveness of computation and the approximation of human vision through algorithmic approaches. The second example, Crawford and Joler's *Anatomy of an AI System*, zooms out to show the internal difficulties of taking part or a whole of a system. The indecision revealed in these situations of uncertainty are cause for reflection and re-evaluation if not a revaluation. If the distance between a face and not a face may be a matter of a single pixel for a computer (Su et al. 2019), we must consider whether our own, human aesthetic categories are equally flimsy. Rather than acting to establish new aesthetic categories in place of the old, an uncertain aesthetic may seek out blurriness, indecision and conflictedness as values. Such an ideology would champion irresolution in the face of imperatives to decide. What art and aesthetics do for artificial intelligence and machine learning is that they can reveal the irrationality found in technologies descended from rationalism. The digital image is dynamic and not merely an electronic version of a traditional, fixed image such as a painting or a printed photograph. Additionally, an image produced using machine learning is a part of a functional system, meaning that the generated image is inextricably linked to databases, processes and networks from which it emerges and within which it is situated. To more fully explore the aesthetic potential of machine learning, thus, it is essential to grasp its many internal uncertainties, not necessarily to resolve them, but to acknowledge the aporias they give access to as opportunities for new directions.

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Helping Machines (Help Us) Make Mistakes: Narrativity in Generative Art

Keywords
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artificial Intelligence
error
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narrativity
new media art
programming
software

The development of automatic narrative systems has been largely driven by the engineering tendency to anthropomorphize the machine logic so they can 'tell stories' similar to how humans do. From the artists' perspective, however, the experimentation with their media is often more important than the (plausibility of) storytelling, and it often unfolds in non-verbal events that have a potential to generate diverse narratives through experience of the audience. We discuss the emergence of the creative practices that enrich the poetic repertoire of new media art by playfully utilizing the machine flaws, irregularities, errors and systemic technical imperfections thus revealing the human biases and fallacies entangled with technology. One of the implications of these practices is that if the AI research opens up a broader space in which a machine could achieve its own authorial voice, our concept and understanding of the narrative would need to be reconsidered.

1 INTRODUCTION

This paper examines the ways in which generative narrative artworks contribute to the creative and expressive repertoire of new media art. It focuses on the complex interrelatedness between the procedural (algorithmic) thinking which is one of the key elements in generative art, and the narrativity as one of the human universals. (Brown 1991) We explore different perspectives of generative narrativity by discussing the art projects which exemplify the artists' abilities to transcend and/or question the conceptual, expressive and aesthetic limits of instruction- or code-based art. We observe this theme primarily from the aspect of the artists' creative thinking and critical evaluation. The aim of our study is to show that the expressive, emotional and cognitive impact of generative art expands our understanding of narrativity by including the audience's comprehension of the system logic and algorithms used in creation of the work. We believe that the anthropomorphizing of intelligent narrative machines results in the impoverished narratives or pale imitations of the existing storytelling methods. Experimenting with the authentic authorial voices of the machines can open up new fields of research in the arts and in the sciences, which can help us define the more robust concept of narrativity and its roles.

1.1 Generative Art and New Media Art

The conceptions of generative art in contemporary discourse differ by inclusiveness. (Galanter 2003; Arns 2004; Quaranta 2006; Boden and Edmonds 2009; Watz 2010; Pearson 2011) In this text, we perceive generative art broadly, as a heterogeneous realm of artistic approaches based upon combining the predefined elements with different factors of unpredictability in conceptualizing, producing and presenting the artwork, thus formalizing the uncontrollability of the creative process and underlining the contextual nature of art. (Dorin et al. 2012) Like all other human endeavors, the arts always emerge from an interplay between control and accident, and exist in a probabilistic universe, so in that sense all the arts are generative. However, the awareness of the impossibility to absolutely control the creative process, its outcomes, perception, reception, interpretation and further use is often not the artists' principal motivation, but it becomes central in generative art. Generative art appreciates the artwork as a dynamic catalyzing event or process, inspired by curiosity and playfulness, susceptible to chance and open for change. (Grba 2015)

Contemporary generative art has emerged from the Modernist exploration of the nature of creativity, of the material, semantic and contextual identity of the artwork, influenced by information theory, systems theory, cybernetics and semiotics throughout twentieth century. (Weibel 2007, Rosen 2011) The use of instructions and language in minimalism and in conceptual art introduced the algorithm and procedure as formal elements but also as participatory factors, e.g. in Sol LeWitt, Lawrence Weiner and George Brecht. It emphasized that the operation of an algorithm, as a structured set of rules and methods, may be well comprehended but its outcomes can evade prediction. The cognitive tension between the apparent banality of pre-planned systems and their surprising outcomes became one of the major poetic elements in Steve Reich's opus in the 1960's with astonishing effects of phase shifting, iteration, repetition and accumulation of musical figures, in processual artworks such as Hans Haacke's *Condensation Cube* (1963), and in some land art projects such as Walter DeMaria's *The Lightning Field* (1977). (Grba 2015)

Generative techniques figure prominently in new media art. Aware of its dubious nature and diverse meanings, we use the term *new media art* to denote a rich repertoire of practices based upon the innovative, experimental, direct or indirect application and exploration of emerging technologies often in correlation with scientific research, which strategically redefine the notions of traditional and new media, and challenge the distinctions between artistic process, experience and product.

Generative new media art expanded in the early 21st century with the development of hardware and software systems, coding environments and computational techniques for efficient manipulation, transformation and interaction of various types of data. Diversifying conceptually beyond purely computation-based methodologies—which drew considerable and well-deserved criticism (Arns 2004, Watz 2010) but are still widely recognized as *the* generative art—the production of contemporary generative art unfolds into a broad spectrum of creative endeavors with different poetics and incentives, many of which deal with narrativity.

1.2 Narrative and Narrativity

For our consideration of narratives in generative art, we combine Abbott's 'bare minimum' definition of narrative as *a representation of an event or series of events* (Abbott 2008, 12) with the second definition of narrative (noun) in Cambridge University Press English dictionary as *a particular way of explaining or understanding events.* (V.A. 2019) This generic approach is useful and necessary because we are analyzing hybrid new media artworks which often do not exhibit the obvious narrative qualities that we find in traditional literature, film, theater or computer games. The more specific definitions of the term *narrative* such *as a series of events connected in cause-effect relationship* (Bordwell and Thompson 2004) may be too exclusive since the examples in this paper often introduce non-linear and discontinuous processual interrelations that are nevertheless narrative.

Taking the Oxford Dictionary of English definition of *narrativity* (noun) as the *quality* or *condition of presenting the narrative*, we understand narrativity as a feature of the artwork to be experienced or perceived as narrative (primarily or derivatively) and/or to motivate the viewers to develop their own narratives. (V.A. 2007) Taking this broader view, we aim not to expand on the theory of narrativity (Sturgess 1992) but to examine how generative systems and methodologies can be(come) narrative and contribute to the poetic breadth of new media art.

1.3 Generative Narrativity

According to our concepts of generative art, narrative and narrativity, we use the term *generative narrativity* to describe the narrativity of generative art projects. These projects primarily feature the creative development, design and application of the systems which function procedurally, autonomously, largely rely on chance, treat narrative as the source material and/or as an experiential medium, and push the artists to inventively address and design the supporting structures for impactful and experiential transference of narrativity between an art piece and its audience.

2 CONCEALING THE MACHINIC IMPERFECTIONS

Amongst a range of the 18th and 19th centuries automata such as Jacques Vauconson's *Flute Player* (1730's), Jaquet Droz's *Automata* (1768-1774) or Joseph Faber's talking machine *Euphonia* (1845), John Clark's invention *The Eureka* (1845) stands out as an early predecessor of generative narrative systems. It could produce Latin verses with a pull of a lever, through the mechanism that utilized a complex system of pulleys, gears and weights in order to automate generation of the verses. Because of the strict rules of Latin hexameter, this wooden machine was capable of flawlessly randomizing words and arranging them in the plausible output, which enabled the inventor to hide the possible mistakes of the system. A significant degree of the success, popularity and historical impact of *The Eureka* and many other machines of that time relied on the spectacle and novelty that accompanied the automatic generation of the verses. (Hall 2007)

A somewhat ambivalent approach to concealing the machinic imperfections reflects in the early computer art experiments, partly due to the variety of the creators' motivations and approaches. Besides his pioneering work in the development of computer music and computer games, British scientist Christopher Strachey had anticipated the computer experiments with literature. Strachey's program *Love Letters* (1952) constructed four sentence long love notes using the random number generator of Ferranti Mark I computer. The system was capable of combining salutations, nouns, adverbs, adjectives and verbs from an appropriately compiled lexical database. Although semantically inarticulate, the sentences were syntactically acceptable and plausible. The love letters looked like they had been written by a low-fluency English speaking person or as if they had been produced by some of contemporary online machine-translation services. (Strachey 1952) This project, even though it was programmed on a powerful computer system at that time, retains both the logic and the complexity close to Clark's *Eureka*.

Seven years later, on Zuse Z22 computer at Technische Hochschule in Stuttgart, German mathematician Theo Lutz created a stochastic text generator. Using a 100-word lexicon extracted from Franz Kafka's novel *The Castle* (*Das Schloss*, 1926), the program constructed more or less plausible sentence pairs. *Tape Mark 1* software, created by the Italian writer Nanni

Balestrini for the IBM 7070 system, produced generative poetry by recombining the words from one short quote taken from Lao Tzu's *Tao Te Ching* (4th C. BC), one from Michihito Hachiya's *Hiroshima Diary* (*Diario di Hiroshima*, 1955) and one from Paul Goldwin's *The Mystery of the Elevator.* However, the *Tape Mark 1* poems were syntactically satisfactory and semantically plausible at least partly thanks to the subsequent hand editing of punctuation and grammar. (Funkhouser 2007; Clements 2013)

Between 1966 and 1968 on IBM 7090 system at the German Computing Center in Darmstadt, Gerhard Stickel and Otto Beckmann generated the first song lyrics (texts for vocal lines) titled *Monte-Carlo Texts* (*Monte-Carlo-Texte*) within their *Verbal Block-Montages* series (*Verbale Blockmontagen*). (Stickel 1967) Finally, the 1280-page novel *People's Book: Room Alphabet* (*Volksbuch: Raumalphabet*)—that Austrian architect Heidulf Gerngross produced between 1968 and 1978 using software which connected text passages from newspaper articles, detective stories, science fiction, folk novels, poems and mythology—stands as a monumental example of early computer-based generative literature. (Franke 1985)

Computer experiments in organizing and manipulating text continued during the 1960's and 1970's by the engineers, scientists and artists of various interests and profiles, such as Marc Adrian, Waldemar Cordeiro, Rul Gunzenhäuser, Brion Gysin and Ian Somerville, Manfred Krause, Gotz F. Schaudt, Jean A. Baudot, Alison Knowles, James Tenney, Edwin Morgan, R. John Lansdown and Poetry Group (Robin Shirley, Graham Wallen, Jeff Harris and Lynette Willoughby). In different ways they experimented with the stochastic lexicons and with syntactical rules in order to achieve the plausibility through semantic coherence but at the same time to probe and discern the semantic rules and principles of generative grammar which describes syntax as a set of logical rules that can produce infinite number of grammatical sentences in a language and assign them all the correct structural description.

One of the first chatting programs—*ELIZA*—written by Joseph Weizenbaum in 1964, pushed the performance and the audience's experience of generative narratives a step further. Designed by applying the basic rules of Rogerian psychotherapy to Alan Turing's *Imitation Game* (Miller 2001), ELIZA appropriated, repeated and reordered parts of the user's input, modifying and altering between pools of possible reply options. Although this early attempt on creating computation-based simulation of artificial intelligence never managed to pass the Turing test, many users, starting with Weizenbaum's secretary, attributed the human-like feelings and emotions to *ELIZA* while interacting with it. (Weizenbaum 1966)

With *ELIZA*, as well as with other simple generative narrative machines, the users tend to submit their desires to the logic of the machine. Discussing the relationship between a player and the computer game algorithm in *Gaming*, Alexander Galloway outlined this tendency observing that some games have the "ability to arrest the desires of the operator in a sort of poetry of the algorithm". (Galloway 2006)

Video game *Façade* (2005) made by Michael Mateas and Andrew Stern uses a chatbot system as the core element of the gameplay. Chatting with two virtual characters who are also a couple, the player can improve or diminish their relationship. Like with the Choose Your Own Adventure book series, in *Façade* we are facing a limited number of predefined branches and endings of the story. This project's design aims to establish a plausible narrative experience by hiding the errors that ensue from the system limitations. When we probe such 'intelligent' system, it responds with a relatively small subset from the pool of pre-programmed events so in just a few questions we can make it reveal its modesty by choosing a wrong event.

Similarly, when we try out contemporary AI-driven chatbots such as Siri, Alexa or Google Assistant, we often make an effort to establish a relation with these systems by tricking them into giving out the unexpected results, into making mistakes that will surprise us. Although these systems are designed to mask their imperfections behind the efficiency and the ingenuity of their spectacle generation, we desire to experience their authenticity in their flaws.

3 SELECTIVE SEMANTICS

Comparably to the simple generative systems optimized to generate plausible narratives, many generative narrative artworks function as signal-processing machines. In automatic writing—which involves writing without thinking, logical reasoning or conscious manipulating the content—our mind, thoughts and memories are treated as the elements of a signal processor. André Breton and Philippe Soupault developed this method in the early 20th century so they could spontaneously capture the uncontrolled and random thoughts, as in:

> "The great curtains of the sky draw open. A buzzing protests this hasty departure. Who can run so softly? The names lose their faces. The street becomes a deserted track. (Breton and Soupault 1985)

They believed that uncensored recording of free associations facilitates the emergence of unique and deep levels of consciousness. However, if we start modifying the signals (free associations and uncensored thoughts) with our logical reasoning, the results will look manipulated, edited or 'deformed'.

In generative art, certain qualitative phenomenological aspects can be selectively quantified and turned into something else. This principle of applying an external tool/system to spontaneously change or transcode the input signal and get surprising results can be a theme in itself. Introduced by Brion Gysin in Paris in 1959 and adopted by William Burroughs, the cut-up technique improved the 'signals' one can generate with the earlier generative method of Dadaist poetry by selectively rearranging the random fragments of text. Borroughs claimed that "You cannot will spontaneity. But you can introduce the unpredictable spontaneous factor with a pair of scissors." (Burroughs 1963)

The online profit-oriented processual recognition of linguistic and behavioral patterns was deftly subverted by Mimi Cabell and Jason Huff in *American Psycho* (2012). The artists mutually Gmailed all the pages of Bret Easton Ellis' novel *American Psycho* (1991), one page per email, and correspondingly annotated the original text with the Google ads generated with each email. Then they erased the original text leaving only the chapter titles and the adds as footnotes. Printed and bound in the book format, *American Psycho* recursively employs the early 21st century business and marketing strategizing based upon data-mining to process the narrative about the paroxisms of business culture in the early 21st century.

As an essentially generative technique, the supercut was both elevated conceptually and charged processually with meta-political critique in Luke DuBois' brilliant projects *Acceptance* (2012) and *Acceptance 2016* (2016), the two-channel video installations in which the acceptance speeches given by the two major-party presidential candidates (Obama and Romney in 2012, Clinton and Trump in 2016) mutually synchronize to the words and phrases each of them speaks, which are 75-80% identical but distributed differently.

The filtering/processing machine in Jonathan Harris' and Greg Hochmuth's project *Network Effect* (2015) also visualizes the power of generated narratives. The artists have designed a web interface that introduces a series of clickable keywords which trigger an ever-changing stream of related videos. For example, a click on the keyword 'kiss' will initiate a stream of automatically shuffled videos of kissing, accompanied with the information about that keyword such as how many people are kissing now, the use of the word 'kiss' in Google books, etc. However, the clicking experience is limited to around 6-10 minutes per day depending on the life expectancy of the country in which the system is being used, and this brings us back to life. That is where this artwork reveals its own cracks and allows permeability by reminding us that it, as well as the Internet, represent new forms of (fictional) reality.

For the installation *Listening Post* (2001-2002), Ben Rubin and Mark Hansen have developed a system that filters content from thousands of internet chat rooms in real-time and displays the processed material on 200 LED screens. As we watch the filtered messages appear on screens, we also hear eight different computer-synthesized voices produced with customized text-to-speech software. Sometimes the system filters only the messages that start with "I am" and then we can hear the snippets: "I am 18", "I am from Latvia", "I am hot!", etc. The artists have defined how this system works, but it is the machine that performs autonomously and once the audience understands its logic, the experience becomes even more meaningful and impactful.

In simple generative narrative systems such as Dadaist poetry, the audience's engagement with the work is conditioned by knowing the operational logic of the machine/system. In the signal-processing generative machines, the audience experiences a more independent work of art which doesn't require as much exposition. The audience, however, still searches for the errors, irregularities, surprises, perhaps some deep levels of yet undiscovered machine consciousness or poetic aura.

4 EMBRACING THE UNINTELLIGENCE

The early 20th century artists who experimented with generative narratives were also discovering the alternative ways of connecting with the audience. Their relatively simple generative mechanisms produced fragmented and cryptic narratives which required an additional layer in order to motivate and help the audience experience the work. In Dadaist poetry, for example, the artists were focusing primarily on designing a system rather than on creating logical or plausible narratives. In order to engage with the artwork, the audience needed to understand the properties of the system for generating the narrative. Without appreciating the system logic, we could try to make these lines plausible:

> prices they are yesterday suitable next pictures/
> appreciate the dream era of the eyes/
> pompously that to recite the gospel sort darkens/
> group apotheosis imagine said he fatality power of colours/
> carved flies (in the theatre) flabbergasted reality a delight/

It is difficult to find sense in these lines, but if we understand the rules for their generation, our reading will be entirely different. In *Dada Manifesto of Feeble Love and Bitter Love* (1920), Tristan Tzara wrote the instructions for making a Dadaist poem:

> Take a newspaper. Take some scissors. Choose from this paper an article of the length you want to make your poem. Cut out the article. Next carefully cut out each of the words that make up this article and put them all in a bag. Shake gently. Next take out each cutting one after the other. Copy conscientiously in the order in which they left the bag... (Tzara 2017)

With this information about the generative system and after second reading, we start to get closer to the narrative. We slowly enter the magic circle of engagement with the artwork and while we read, we can picture the bag, the newspaper cut outs, the sounds of slicing scissors and other elements of this system. If we do not consider the system and if we don't envision the operation of this simple generative platform, our reading and interaction with the piece will be limited. In this type of work, for both the author and the reader, experiencing the technological, procedural and machinic becomes equally or more significant than comprehending the semiotic qualities of the generated narrative. The content of this type of works includes the generative system, and our engagement with the system functions like an expository device in traditional narratives, which simultaneously introduces us to the artwork and triggers the unfolding of the narrative.

In one of the early works from Oulipo's doctrine—*A Hundred Thousand Billion Poems* (1961)—Raymond Queneau has created a simple system which can generate a combination of 10^{14} different poems. It consisted of ten 14-line sonnets, with each line cut out as a separate strip. While interacting with this system, we have to value its logical properties on the same level on which we engage with its generated outcomes and it would be 'wrong' to only focus on the plausibility of poetry. Nick Montfort's *World Clock* (2013) is a 246-page book generated by 169 lines of code. Its structure resembles Queneau's *Exercises in Style* (1947) in which 99 versions of one story are written in different styles. In *World Clock*, there are 1440 incidents/variations of the story. Each incident starts by explaining the time and place of the event, then illustrating a random character, and finishing the story with a different action, randomly selected from an array of predetermined actions. Darius Kazemi, one of the jurors in the computer-generated novel competition NaNoGenMo, states that reading the *World Clock* is more an exercise in endurance than indulging yourself in quality of the story. (Dzieza 2014)

Even when generative system features no linguistic material, it has a potential to become narrative thanks to human affinity for establishing mental associations through comparison, abstraction, categorization, analogies and metaphors. Nam June Paik's early generative experiments with sound and video rely on this principle. His sound installation *Fluxusobjekt Random Access* (1962-1963), for example, borrowing its title and concept from computer technology, elegantly deconstructs the dictate of linear succession in reproduction of recorded sound. The installation comprised two sets of magnetic audio tape removed from the reel and cut in various lengths. One set was assembled on the wall in a wild composition, and another in a parallel grid on a horizontal looped conveyor. A detached playback head with extended wiring enabled the audience to choose the parts of tape but also the speed in which to slide the head and play the sounds. (Decker-Phillips 2010)

Paik's early works established a strong legacy of rebellious imagination in experimental art. In his debut feature *Mysterious Object at Noon* (2000), Apichatpong Weerasethakul deconstructed the dictate of linearity and logical clarity in conventional cinema by appropriating the surrealist technique of Exquisite Corpse. His crew travelled through Thailand villages, telling the villagers the story that they filmed in the previously visited village, and asking them to continue the story by reenacting or narrating it. The resulting feature-length film with a fragmented narrative structure embraces the noise, mistakes and coincidences between different stories. In a way, it makes the narrative implausibility desirable. Paik's approach of hacking and transcoding also resonates conceptually with a number of technically sophisticated projects in generative and interactive art, such as Matt Richardson's *Descriptive Camera* (2012) in which the temporary image generates the narrative interpreted by the human operator—as opposed to *Mysterious Object…* in which every narrative section generates the following narrative. We point the *Descriptive Camera* at a subject and press the shutter button to capture the scene but instead of showing an image, it uses online human labor via Amazon's Mechanical Turk service to generate a text description of the scene.

5 MACHINE LEARNING MISTAKES

Developing technically more complex generative narrative systems, computer scientists have been pursuing the ways of making the machines able to write like humans. And in the best-case scenarios these constructed machines have been capable of rendering the impoverished narratives or weak imitations of the stories created by humans.

James Meehan's *Tale-Spin* (1976) was in essence a simple generative narrative machine with an extra layer which attempted to understand how characters of the story felt, what action they could perform, or what their environment was like. The audience could influence the development of the story by choosing all these options through the interface of *Tale-Spin*. Although Meehan spent a lot of time planning the unfolding generated narratives, his system kept generating mis-spun stories which were often unintentionally humorous and attracted more attention than the well-spun ones:

> Henry Ant was thirsty. He walked over to the river bank where his good friend Bill Bird was sitting. Henry slipped and fell in the river. Gravity drowned. (Wardrip-Fruin 2006)

In the misplaced sentence 'Gravity drowned.' we may start noticing that this machine attains its unique poetics as it reminds us that it exists by malfunctioning.

With recent AI and ML systems, the structural and/or the formal elements that convey the narrative meaning become malleable. In *sCrAmBlEd?HaCkZ!* (2006) Sven König explored the concept of real-time procedural audiovisual synthesis from the arbitrary sample pool that elevates the narrative structure. *sCrAmBlEd?HaCkZ!* applies the psychoacoustic techniques to calculate the spectrum signatures of the sound snippets from the stored video material and saves them in a multidimensional database that is searched in real-time to mimic any input sound by playing the best-matching audio snippets and their corresponding videos. (König 2006)

Procedural audiovisual synthesis was advanced through the application of neural networking and machine learning by Parag Kumar Mital in his PhD project *YouTube Smash Up* (2012-2014). Each week, this online software takes the #1 YouTube video of the week and resynthesizes it using algorithm that collages the appropriate fragments of sonic and visual material coming only from the remaining nine of the Top 10 YouTube videos. (Mital 2014) It produces a surreal animated effect, visually resembling Arcimboldo's grotesque pareidolic compositions.

A more demanding, machine-based synthesis of coherent film structure and plausible narrative was tackled by Oscar Sharp and Ross Goodwin in *Sunspring* (2016). Well versed in natural language processing and neural networks, Goodwin programmed a long short-term memory recurrent neural network and, for the learning stage, supplied it with a number of the 1980's and 1990's sci-fi movie screenplays found on the Internet. The software, which appropriately 'named' itself Benjamin, generated the screenplay as well as the screen directions around the given prompts. Sharp produced *Sunspring* accordingly. The film brims with awkward lines and plot inconsistencies, but it qualified with the top ten festival entries, inspiring one of the judges to say 'I'll give them top marks if they promise never to do this again'. (Newitz 2016) *Sunspring* playfully reverses the 'Deep Content' technology of What is My Movie web service, which analyzes transcripts, audiovisual patterns and any form of data-feed that describes the video content itself, automatically converts it into advanced metadata which is then processed by a machine learning system that matches the metadata with the natural language queries. (Valossa 2016) Far from being forcefully plausible, the experience of watching *Sunspring* takes us back to the Dadaist poetry experiments. If we didn't know that it was written by an AI, it would be difficult to engage with the film. It is evident here that even the relatively advanced AI systems make mistakes when attempting to replicate the plausibility of human-written stories.

6 LEARNING FROM THE MACHINE LEARNING MISTAKES

The successful generative narrative artworks are powerful tools for blending the elements of unrelated perceptual and/or cognitive matrices into the new matrices of meaning. They tell us stories but, more importantly, they stimulate our imagination and motivate creativity by revealing or suggesting their background thinking processes in an engaging way. The joy and fun in the reception of generative art projects come from the viewer's own ability to build concepts, stories and predictions from the available information about the unfolding phenomena. Similarly to computer software, they encapsulate specific intellectual energy which can be engaged implicitly or explicitly and incite new, often surprising, configurations and ideas. (Grba 2015) By reiterating the simple question: *what is narrative?*, generative artworks inspire our amazement with storytelling, and at the same time broaden our critical understanding of the concept of narrativity by reminding us that the ideas are basically the networks of other ideas, and that we make our ideas and they make us in return. (Johnson 2014)

It would therefore be wrong to force generative narrative systems to act like human narrators. (Aarseth 1997) When the designers of AI storytelling platforms get more comfortable to freely explore the non-human modes of narrativity, to smartly embrace the imperfections of system logic instead of anthropomorphizing them (intentionally or unintentionally), we will move a step further toward expanding our expressive potentials and our understanding of language as the key interface for human-human, human-machine and machine-machine relations. By elevating the dynamics of storytelling as a verbal representation of states, scenes or situations, we will also enrich our appreciation of the fact that the narrative is always uniquely performative, the story always a series of unfolding events. As Google AI puts it:

> it's all right here.
> everything is all right here.
> it's all right here.
> it's all right here.
> we are all right here.
> come here in five minutes.

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Art-Science Collaboration: The Role of Problematization and Artefact use

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Collaboration between artists and scientists is often thought to benefit scientific creativity, the production of scientific knowledge that is both novel and of high quality. The added value of artists could be explained by the artist's skills in problematization, i.e. the skill of criticising theories to find new interesting outcomes; and the tendency to self-create artefacts to find common ground and ease communication to bridge the languages of different disciplines. In the present paper, a first experimental look is taken at the role of problematization and artefact use during art-science collaboration in early stages of the scientific process, in a student sample, where existing knowledge is investigated to develop a research question. The results of the study showed that self-created artefacts are a valuable asset in the communication between artists and scientists, even contributing to the novelty and overall quality of research questions through the process of problematization. As such, the contribution of this paper is preliminary experimental evidence of the added value of art-science collaboration for scientific knowledge production, and the role of problematization and self-created artefacts therein.

1 ART-SCIENCE COLLABORATION

"It has long been thought that a theorist is considered great because his theories are true, but this thought is false. A theorist is considered great, not because his theories are true, but because they are interesting" (p.1, Davis, 1971). Scientific creativity, the production of scientific knowledge that is both novel and of high quality, enables us to enjoy the latest technologies, live longer, and understand what it is that makes monumental works of art meaningful (Sawyer, 2011). However, multiple scholars have argued that scientific creativity should be supported more in both education and in research labs to facilitate and speed up the production of ground-breaking scientific knowledge (Sandberg & Alvesson, 2011; Bartunek, Rynes & Ireland, 2006; Davis, 1971; Weick, 1989). As one possible solution, it has been argued to facilitate interdisciplinary collaboration between scientists and artists as a way to support and even enhance scientific creativity.

Many organizations and academics have explored art-science collaboration as a way to either support artistic or scientific creativity (e.g., Richmond, 1984; Borgdorff, 2016; Stapper & Giaccardi; Horvath, 2007; Koskinen et al. 2011; Keyson & Bruns, 2009; Cole & Knowles, 2008). For example, artists now regularly work with material, computer, and life scientists to explore the potential of emerging media for artistic expression (Stocker & Hirsch, 2017). The work produced during such collaborations often contributes to public discussions about scientific advances and its implications for society, e.g. (Nunez, 2019). In turn, scientists have benefitted from art-science collaborations as well. For example, emotion psychologists have learned a great deal from collaborating with actors on how to conduct ecologically valid studies on emotion (Wagner et al., 2016), artistic work has informed the neuroscience of human perception (Zeki, 1999), and technological solutions developed by artists often show potential for real-world application, e.g. (de Rooij et al., 2018). Despite such advances, assumptions about the relationship between art-science collaboration and scientific creativity is too often based on anecdotal evidence, and on ground-breaking projects with mostly implications for the arts, e.g. (Stocker & Hirsch, 2017); but as of yet, less so for the sciences, cf. (de Rooij et al., 2018). This suggests that there is a need for research on how art-science collaboration can benefit scientific creativity.

Therefore, the present study investigates experimentally, in a student sample, the potential of art-science collaboration in the early stages of the scientific process: Where information is gathered, understood, and a research question is formulated. Specifically, it is proposed that artists are typically skilled in problematization, the skill of criticising theories to find new interesting outcomes, which could add to commonly used scientific approaches in a manner that enhances scientific creativity. Furthermore, it is explored whether the artist's tendency to self-create artefacts as a means of finding common ground and communication between the different languages of art and science facilitates the effective use of problematization on scientific creativity during art-science collaboration.

As such, the contribution of the present study is a first experimental look at the role of problematization and artefact use in art-science collaboration during the early stages of the scientific process.

2 THE ROLE OF PROBLEMATIZATION AND ARTEFACT USE

2.1 Creativity during early stages of the scientific process

Art-science collaboration may be particularly fruitful in the early stages of the scientific process, where information is gathered, understood, and research questions need to be formulated (Ruhl, de Rooij, & van Dartel, 2018). Basadur, Graen and Green (1982), however, showed that students find tasks that call for imagination and creativity difficult. An explanation provided by the authors is that schools generally reward systematic working more than creativity. Over the course of their study students showed to be less able to use their imagination than when they entered their educational program. A similar phenomenon is occurring in the academic world (Sandberg & Alvesson, 2011). There are strict methodological rules and social norms tied to studies which researchers are obliged to meet. Similar to schools, academia encourage this. Since researchers want to be sure to meet these standards, they have become more cautious in trying new things. This method for developing research is identified by Sandberg & Alvesson (2011) as: gap-spotting.

Gap-spotting

According to Sandberg & Alvesson (2011) the most commonly used method for formulating research questions is through gap-spotting. Gap-spotting is the development of new research based on what is presently missing in the literature. This can be done via confusion spotting (confusion in literature that needs clarification), neglect spotting (no research has been carried out on the topic) and combinations of the two. Generally, a research question can be considered 'good' if it is truthful and stems from rigorous research (Sandberg & Alvesson, 2011). Since gap-spotting is heavily grounded in existing literature, it is likely to yield truthful and good results. Although these criteria can determine whether a study is 'good', it does not mean the theory is interesting or creative (Bartunek et al., 2006, Davis, 1971, Weick, 1989). According to Davis (1971) what makes a theory interesting and creative is that it challenges the audience's assumptions of the theory. To establish this 'criticising' of a theory, Sandberg & Alvesson (2011) propose problematization as a method for the formulation of research questions; which can help support scientific creativity in these early stages of the scientific process.

Problematization

Sandberg & Alvesson (2011) argue that problematization involves knowing how to think out-of-the-box and different from what is already known. The central goal is "to disrupt the reproduction and continuation of an institutionalized line of reasoning" (2006, p. 32). In other words, it is seen as a means to not only identify but also challenge assumptions underlying existing theory.

From this, novel yet high quality research questions can be formulated. Problematization can occur via several routes. First, critical confrontation, which comprises the identification of shortcomings in a theory. Second, the development of a new idea, where the author claims innovation and does not follow a route mapped by literature. Third, problematization, which is a critical rethinking of a particular solution or theory. Other work and empirical observations are used as building blocks to stand on in the creation of innovative ideas. Following one of these routes for the development of research could support and enhance scientific creativity. According to Cropley, Kaufman and Cropley, problematization is part of novelty when assessing innovation.

Regardless of these newly established frameworks for developing research questions, according to Sandberg & Alvesson (2011) academics tend to prefer gap-spotting, because it is considered safe and uncontroversial. It increases the likelihood that the research will yield truthful and good results, and therefore to be published. This powerful tradition of developing new theory is hard to break. Yet, as argued in the above, it may also get in the way of the scientist's ability to produce knowledge that is novel. Leading to advances that are incremental rather than ground-breaking. One solution that may support and enhance scientific creativity may be to stimulate interdisciplinary collaboration between scientists and researchers from domains other than science where problematization is commonly preferred over gap-spotting.

2.2 Artistic competencies that may enable art-science collaboration

Art-science collaboration may depend on two crucial artistic competencies: 1) skilfulness in problematization, and 2) a tendency to self-create artefacts to aid (interdisciplinary) work.

Problematization as an artistic skill

Artists from various domains may represent such a group of researchers that are skilled in problematization. That is, it appears that the following competencies are generally attributed to artists active in the fine arts and the visual arts (Sullivan, 2010; Oakley, Sperry & Pratt, 2008) as well as artists active in the cultural industry, design and new media (Oakley, Sperry & Pratt, 2008). It is well established that artists are skilled in creating new and innovative concepts (Sullivan, 2010). However, it is not just this creativity that may make them valuable in interdisciplinary collaborations. Oakley, Sperry and Pratt (2008), for instance, stated that artists have a high disposition towards critical thinking. As a result of this disposition, artists often instigate critical discussions, which is useful for breaking down existing barriers and taboos within disciplines (Heinsius & Lehikoinen, 2013). Next to this, artists offer inspiration for topics to discuss, partly due to their preference for interpretive rather than analytical working methods (Hirsch et al., 2017). These assumed competencies are needed to be skilled in problematization (Sandberg & Alvesson, 2011). At least, more so than scientists. This skill can contribute to problematising theories, resulting in more novel research.

Artefact use as a facilitator

Artists may also bring a second skill to the table that is needed to unlock the potential of art-science collaboration within the context of scientific creativity, e.g. (van Dartel & de Rooij, 2019). Sullivan (2010) states that artists have the ability to, and systematically do, visualize problems and how they should be solved, also known as artistic cognition. Sullivan argues that an artist "uses many visual cognitive strategies that dislodge discipline boundaries" (p. 148). This is often aided by their skill in self-creating artefacts to find common ground and communicate ideas. Research through design methods suggests a similar function of self-created artefacts. According to Stappers et al. (2014), an artefact is a way to connect abstract theories and a carrier for (interdisciplinary) discussions. For example, artefacts can be used to demonstrate the possibilities of a new combination of elements, give direction to and unfold research by challenging it (Smith et al. 2016), be a vehicle for theory building (Koskinen et al. 2011, Stappers 2007, Wensveen & Matthews 2014), and help establish critical areas of concern and judgment (Gaver, 2012). Fundamentally, artefacts serve as a visualization of the current situation so this can be evaluated (Lim, Stolterman & Tenenberg, 2008) and during this evaluation new ideas and concepts can arise (Biggs & Karlsson, 2010). That is, visualizing ideas, both the scientist and artist could understand each other more clearly. It may therefore follow that to make use of the artist's skills in problematization, the self-creation of artefacts is needed to facilitate a clear overview of critical areas in a study based on which new ideas for research can be generated.

In the present study, it is therefore explored experimentally whether problematization enhances scientific creativity during art-science collaboration; and whether the self-creation of artefacts enables this effect of problematization.

3 METHOD

To explore the conjectures an experiment was conducted with a between-subjects design and with group type (i.e., type of collaboration) as the three-level manipulated factor.

3.1 Participants

Thirty students with a background in new media and communication science were recruited from Tilburg University (M_{age} = 22, SD_{age} = 2.61, 17 female, 13 male), and twenty-three students with a background in new media art (M_{age} = 23, SD_{age} = 2.52, 12 female, 11 male) were recruited from a media art program at AVANS University of Applied Sciences. In exchange for their participation, the students received course credit. The experiment was executed in the form of a workshop for which they were divided into three experimental groups: art-science (n = 8), art-art (n = 7) and science-science (n = 11) collaborations. Assignment to the groups was, aside from assignment based on background, done randomly.

3.3 Materials and measurements

Workshop about the potential of psychophysiology for new media

To test the role of artefact use and problematization in art-science collaboration a workshop was developed where participants were asked to develop a research question about psychophysiology, i.e., the correlations between physiological responses (e.g., heart rate) and psychological phenomena (e.g., emotions), within the context of new media research (e.g., using heart rate as a communication channel). At the start of the workshop the participants were familiarised with the topic of psychophysiology and its potential for new media via an introductory presentation by a workshop leader. The structure of the workshop was explained in this introduction as well. Participants were informed of the 45 minutes timeframe to develop a research question. They were advised to use the first 20 minutes to explore the phenomenon of psychophysiology. To this end, participants had access to the introductory presentation, a selection of relevant scientific research, and a psychophysiological sensor and visualization kit for hands-on exploration. A laptop with access to the internet was provided in case the participants wanted to search for more information or inspiration. After this initial exploration they were advised to brainstorm research ideas for 15 minutes; after which they were advised to spend the last 10 minutes of the workshop to converge upon and develop a research question. To enable the self-creation of artefacts, materials such as A3 paper and pencils were available during the workshop. Throughout the workshop, the participants were given ample opportunity to ask questions. During the forty-five minutes of collaboration the researcher remained in the room to observe the process and assist where needed.

Assessing problematization

Problematization was assessed in two ways. First, the disposition to problematize was self-reported before the workshop using the 5-point Likert scales (1 = not at all; 5 = extremely) taken from Runco, Plucker & Lim (2001), e.g. *I am able to think up answers to problems that haven't already been figured out.* The items were aggregated (mean) for each participant for use in the analysis. Second, problematization was measured as part of novelty, refer to section assessing scientific creativity. The items were based on Cropley, Kaufman & Cropley (2011) and measured whether the research question draws attention to shortcomings in other theories and how theories can be improved. This separate variable was created out of the three items measuring novelty to test whether self-create an artefact could contribute to problematizing theory, resulting in more novel research questions.

Assessing artefact use

Artefact use was self-reported using three 5-point Likert scales (1 = not at all; 5 = extremely): The use of an artefact made it easier for us to communicate; *The artefact contributed to the process of creating a research question; Without the artefact the collaboration would have been more difficult.* These were aggregated (mean) for each participant for use in the analysis.

Assessing scientific creativity

The quality of the research questions developed during the workshop was used as a proxy to assess scientific creativity during early stages of the scientific process. The novelty of the research questions was assessed with the novelty items, specifically: the use of existing knowledge, the initiation of new knowledge and problematization, from Cropley, Kaufman & Cropley (2011); whereas overall quality was assessed with the relevance, e.g. the *research question accurately reflects conventional knowledge,* effectiveness, e.g. *the research is easy to execute*, and elegance, e.g. *the research question is nicely formulated*, items. From these scales, safety and durability of the subscale relevance and external elegance, from the subscale elegance were excluded, as these could not be applied to the evaluation of research questions. Two independent expert raters used the scales to assess each of the research questions on 5-point Likert scale (1 = not at all to 5 = extremely). Scores on the items for novelty and for overall quality were aggregated (mean) for each participant to use in the analysis.

3.4 Procedure

Upon arrival participants were seated collectively in session of 6-10 people. First, they were introduced to the study, signed informed consent, and filled in a short questionnaire to capture their socio-demographics (incl. age, gender, background) and problematization disposition. Participants were then assigned based on their background, but otherwise randomly, to either a science-science, art-science, or art-art duo. The workshop with the science-science duos was organised at the research university, while the workshop with the art-art and art-science duos was organised at the art academy (the science students participating in the art-science duos travelled in). Hereafter, participants engaged in the workshop. After the workshop, the participants filled in a further questionnaire about the quality and novelty of the research questions and about their use of self-created artefacts. Finally, the researchers asked the participants to provide feedback on the workshop, the procedure and the cooperation between them and their partner. The research questions produced by the duos were rated by two experts as a proxy to assess scientific creativity during the early stages of the scientific process.

4 RESULTS

	Cronbach Alpha	Art-Art Mean (SD)	Science-Science Mean (SD)	Art-Science Mean (SD)
Problematization disposition	.727	3.53 (.59)	3.36 (.46)	3.25 (.57)
Problematization novelty	.700	3.38 (.58)	3.15 (.73)	3.52 (.58)
Artefact use	.961	3.89 (1.18)	2.65 (1.55)	4.06 (.52)
Research question novelty	.812	3.28 (.44)	2.87 (.48)	3.42 (.46)
Research question quality	.758	3.20 (.42)	2.94 (.51)	3.50 (.28)

Table. 1.
Cronbach's alpha and overall of mean (standard deviation) by group type.

4.1 The role of problematization

The role of problematization during art-science collaboration was explored by conducting several statistical tests. An independent t-test was conducted with artistic versus scientific background as the independent variable, and problematization disposition as the dependent variable. No significant difference was found, *Mdif* = .14, $t(51) = .94$, $p = .350$. However, a regression analysis showed that problematization disposition also did not significantly predict problematization novelty, $b = .16$, $\beta = .13$, $t(51) = .93$, $p = .359$. To further explore this a generalised linear model was calculated with group type as the independent variable, novelty as the dependent variable, and problematization disposition as a moderator. The omnibus test showed the test model to be better than the null-model, rejecting the null hypothesis, $\lambda = 15.98$, $df = 5$, $p = .007$. The test of model effects showed that the addition of problematization to the model was a significant improvement, $W_T = 9.06$, $df = 2$, $p = .029$, over the model without problematization disposition as the covariant, $W_T = 1.82$, $df = 3$, $p = .402$. However, the tests of fixed coefficients showed that the effect was only significant for the art-art group, $W_T = 8.22$, $p = .004$, 95% CI [.34, 1.79]. This relationship was positive, $B = 1.06$. Thus, this suggests that problematization disposition positively contributes to novelty, but only for art-art collaboration.

4.2 The role of artefact use

As conjectured, however, the added value of problematization that artists may add to art-science collaboration, may be dependent on the self-creation of artefacts to bridge the two disciplines.

To explore this an ANOVA was used with group type as the independent variable and artefact use as the dependent variable. The data for art-art (z-scores$_{kewness}$ = -2.57) and art-science (z-scores$_{kewness}$ = 3.34) were not normally distributed, therefore the p-values could be unreliable. Equal variances were not assumed, $F(2, 50) = 5.71$, $p = .006$, so the Welch statistic was reported. The results showed that there was a significant difference in the usefulness of self-created artefacts between the groups, $F(2, 28.14) = 7.73$, $p = .002$, $\eta^2 = .23$. Post-hoc comparisons (Tukey HSD) showed that artefact use contributed significantly more to the collaboration between artists and scientists than between scientists, $M_{diff} = 1.41$, $p = .003$, $d = 1.22$; and between artists than between scientists, Mdiff = 1.24, $p = .010$, $d = .90$; but not more between collaboration among artists versus collaboration between artists and scientists, $M_{diff} = .17$, $p = 1.00$. This suggests that people engaged in art-science and art-art collaborations find creating an artefact more helpful than people engaged in science-science collaborations.

Furthermore, a generalized linear model was used with group type as the independent variable, problematization novelty as the dependent variable, and artefact use as the moderator. The omnibus test showed that the test model was better than the null-model, rejecting the null hypothesis, = 12.90, $df = 2$, $p = .002$. The test of model effects showed that the addition of artefact use to the model was a significant improvement, $W_T = 15.13$, $df = 3$, $p = .002$, over the model without artefact use, $W_T = 13.00$, $df = 2$, $p = .002$. The parameter tests showed that the effect was significant only for the art-science group, $W_T = 9.92$, $p = .002$, 95% CI [.90, 3.88]. This relationship was positive, $B = 2.39$. Tests adding problematization disposition as moderator (nor in addition to problematization novelty) did not yield further results that contribute to the reported findings. As such, these results suggests that the self-creation of artefacts facilitates problematization specifically during art-science collaboration.

To explore whether the positive effects of art-science collaboration on scientific creativity depended on the found relationship between artefact use, a generalized linear model was calculated with group type as the independent variable, independently research question quality as the dependent variable, and artefact use as the moderator. The omnibus test showed that the model was better than the null-model, $\lambda = 24.23$, $df = 5$, $p < .001$. The test of model effects showed that the edition of artefact to the model was a significant improvement, $W_T = 13.16$, $df = 3$, $p = .004$, over the model without artefact, , $W_T = 6.90$, $df = 2$, $p = .032$. The parameter tests showed that the effect was significant only for the art-science group, $W_T = 10.25$, $p = .001$, 95% CI [1.00, 4.17]. This relationship was positive, $B = 2.59$. This finding therefore suggests that the creation of an artefact also positively contributes to the overall quality of research questions in art-science collaborations.

4.3 Relationship with scientific creativity

To explore whether art-science collaboration supports or even enhances scientific creativity and ANOVA was calculated with group type as the independent variable, and independently research question novelty and research question quality as the dependent variables.

For novelty, the data was normally distributed and the assumption of homogeneity was met. The results showed there was a significant difference in novelty between groups, $F(2, 50) = 7.30$, $p = .002$, $\eta^2 = .23$. Post hoc comparisons (Tukey HSD) showed novelty was significantly higher for a collaboration between artists and scientists than between scientists, $M_{diff} = .55$, $p = .002$, $d = 1.17$, and between artists than between scientists, $M_{diff} = .41$, $p = .030$, $d = .87$. This finding suggest that art-science collaborations lead to significantly more novel research questions than science-science, but not art-art.

For overall quality, the data for art-art (z-scores$_{kewness}$ = -2.20) was not normally distributed, therefore the p-values could be unreliable. The assumption of homogeneity was met. The results showed there was a significant difference in overall quality between groups, $F(2, 50) = 7.78$, $p = .001$, $\eta^2 = .24$. Post hoc comparisons (Tukey HSD) showed overall quality was significantly higher for a collaboration between artists and scientists than between scientists, $M_{diff} = .55$, $p = .001$, $d = 1.35$. This finding suggest that art-science collaborations lead to significantly higher overall quality of research questions than science-science.

Further testing revealed no clear relationships within the art-science collaborations for artefact use and novelty. Additionally, the relation between problematization disposition and overall quality was tested, which proved not to be significant. Lastly, the combined effect of problematization disposition and artefact use was tested on novelty and overall quality but showed no clear relationship.

5 CONCLUSION AND DISCUSSION

The presented study explored experimentally, in a student population, the potential of art-science collaboration to support scientific creativity during early stages of the scientific process, and in particular the role of problematization and self-created artefact use therein. The results showed no evidence indicative of a difference between artists and scientists in the sample regarding a disposition to engage in problematization. However, when examining the influence of problematization on the novelty of research questions, problematization did affect this relationship, but only in the collaboration between artists. Rather, the role of problematization in novelty of the research questions depended on the use of self-created artefacts; and the use of self-created artefacts contributed to the overall quality of the research questions developed specifically during the art-science collaborations. This suggests that during art-science collaborations self-creation of artefacts facilitates the problematization of novelty of the research questions, which supports the quality of the research questions that are developed.

Of course, there are also limitations to the presented study that have implications for the validity of the presented results. First, the use of a student sample may not be sufficiently ecologically valid. Case in point is the suggestion that artists have a high disposition toward critical thinking and a high tolerance for uncertainty, which is assumed to underlie a disposition to engage in problematization (Oakley, Sperry and Pratt, 2008); and the suggestion of Sandberg and Alvesson (2011) that scientists are hesitant to try new theories. In the present study, however, artists did not have a higher disposition to engage in problematization than scientists. This could be explained by the use of a student sample. For instance, differences in problematization disposition may emerge later in the artist's and scientist's development. Caution is therefore advised when interpreting this particular result. Second, the null finding between artists and scientists regarding problematization disposition is also interesting in light of conducting experimental studies on art-science collaboration. That is, this null finding could also be explained by the idea that generalization of artists and scientists competencies is misconceived. Indeed, people (and thus artists and scientists) are always subject to individual differences (Goldberg, 1990), which may affect (interdisciplinary) collaboration and scientific creativity in a variety of ways. It is therefore tedious to base experimental studies on competencies attributed to either artists or scientists. Future research needs to take into account that assumptions about artist's and scientist's competencies, despite evidence from previous work, may vary. Using a preselected sample based on assumed competencies is advised. Third, not all relationships between problematization and the production of novel and quality research questions could reliably be tested, e.g. the interaction of problematization and artefact use and their combined moderating effect. This is partly due to the exploratory nature of the study and the relatively low sample size. This in turn invites an increased chance on Type I and Type II errors. We therefore wish to emphasise that the results of this study need to be seen as preliminary, and that confirmation on the basis of this exploratory study is required to achieve more certainty about the role of problematization and artefact use during art-science collaboration; within the context of supporting and enhancing scientific creativity during early stages of the scientific process.

As such, the contribution of this study is that it offers preliminary evidence that suggests that the self-creation of artefacts enables a beneficial effect of art-science collaboration on scientific creativity, possibly via the engagement of artists and scientists in problematization during such collaborations.

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Artworks

xCoAx 2019 Conference on Computation, Communication, Aesthetics & X Milan, Italy

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Signal Polarities

Keywords
signal topographies
psychogeography
digital infrastructures
data portraits

The work *Signal Polarities* is an audio-visual and data psychogeography from urban, rural and natural landscapes related to dependency on wireless networks within diverse sociocultural contexts. The work consists on a series of data portraits depicting social activity in relation to the current digital infrastructures. The portraits are built using the collected information from wireless signal traffic in specific contexts over time using a self-made artefact that records Wi-Fi, Bluetooth, GPS Signals as well as Audio and Image from the environment.

1 DESCRIPTION

We move around the world guided by intelligent maps and instant-traced routes which are perfectly depicted in the palm of our hands thanks to satellite technologies, wireless networks, statistic systems and human exploration endeavours. Thus, we are connected while we walk through streets and we step in and out of flying machines that bring us closer to multiple corners of the world which all exist separated by matter but connected by light through space and time. These is possible thanks to the invisible infrastructures and networks around us, within our urban, rural and natural landscapes where they are all granted.

The work *Signal Polarities* is an audio-visual and data psychogeography from urban, rural and natural landscapes related to the availability and social dependency on wireless internet connectivity within diverse socio-cultural contexts. The work consists on a series of audio-visual portraits which are built using the collected data from wireless signal traffic in specific contexts over time.

A self-made artefact allows to track Wi-Fi radiation, Bluetooth signals, Electro Magnetic Fields and GPS information, as well as record audio and visual data from the surroundings. The data is collected by the device and the information is later pulled down to a computer which integrates it into an interactive database. The device has been conceived as a research instrument in order to understand better how the modern signal landscapes look like in the everyday life of a person, a building, an object, a park or a vehicle. The device has been ideated as a part of a longer research collaboration at the Collegium Helveticum (ETH, UHZ, ZHdK).

The installation consists on a series of audio-visual portraits presenting a collection of recordings from signal landscapes tracking Wi-Fi networks and other electromagnetic signals as they have been recorded by the described artefact. The landscapes include urban, rural and natural areas, in Mexico and Switzerland. The portraits display through image and sound how several locations are invisibly affected by the network radiations and signal traffic around them. There is yet no proof how these radiations affect our lives, and whether they impact social behaviours or health, thus the art work intends to contextualise, depict and materialise these diverse signal traffic scenarios embedded in sociotechnical contexts which further than environmental, have potentially a social, cultural and psychological impact.

The installation is presented through a pair of interfaces. The first one is a map showing the recorded GPS location and the corresponding road as well as the list of Wi-Fi Networks and signal strengths in the near area. The second display shows the data information generating a 3D topography correlated with the Wi-Fi signals interactions which can be partially understood by humans and the machine. I can provide the displays and all materials. Five seconds of audio are replayed in a loop at each location.

Participation supported by Pro Helvetia, Swiss Arts Council.

Fig. 1.
Field recording device produced for "Digital Spaces", a research project from Collegium Helveticum.

Fig. 2.
Pair of Vertical FHD Displays showing installation "Signal Polarities"

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aSail – aSynchronous as in life

Keywords
audiovisual synchronism
perceptual objects
auditory-visual integration
multimodality
sound spatialization
algorithms
aesthetics

An audiovisual experiment, that implements spatio-temporal synchronisation between visible and audible events, happened. This experiment was materialized with light – array of LEDs, and digital sounds widespread by an array of loudspeakers. A computer program, based on a video white noise generator, calculates in real time unpredictable rhythmic sequences that are perceived as precisely located audiovisual events. For xCoAx, the experiment will be re-designed to combine synchronous and asynchronous audiovisual events in order to play with the spatial perception of the space where aSail is installed. Audiovisual asynchronism will convey the perception of distance by simulating the differences between light and sound speeds.

Fig. 1.

1 DESCRIPTION

Single perceptual object

In our everyday experience almost any audible phenomena has a visual event associated to it. For example, in normal conditions, without physical obstacles, when we see a glass crashing on the floor, we also ear the sound of the same glass hitting the floor. Bizlei et Al. (2016) emphasize that auditory and visual objects share particular properties: both have linked features that change over time and perceptually group together the acoustic or visual features that come from a common source. According to Teramoto et Al. (2012) most objects and events in the external world generate concurrent inputs to several different sensory modalities. For a long time researchers assumed that each input (audition and vision) were processed in the brain independently however recent studies on multisensory perception have revealed that different sensory modalities are closely related and mutually interplaying. The phenomena of hearing and seeing at the same time can be named as auditory-visual integration. Bizlei et Al. stated that what we hear and see take strikingly different physical forms, and are necessarily encoded by different sensory receptor organs, but auditory and visual features are effortlessly bound together to create a coherent percept. Binding stimulus features from a common source is not only a problem across sensory systems – within sensory systems, parallel and independent perceptual feature extraction mean that stimulus features, such as pitch and space, must also be appropriately combined into a single perceptual object.

Sail

The goal of Sail—Synchronous as in life, the audiovisual experiment that originates the current submission, is precisely to create a single perceptual object that would affect simultaneously the senses of hearing and seeing in time and space. This object consists of a horizontal line of three hundred RGB LEDs, four equally spaced loudspeakers, also horizontaly aligned, controlled by a computer, a four channel audio card and a microcontroller development system–Teensy 3.6. An original algorithm, implemented as a custom computer program, transmutes a real time white noise digital video signal into a sequencer where pixels brightness, above a variable threshold, trigger synchronous audiovisual events simultaneously on the loudspeakers and on the LEDs. The algorithm also determines the spatialization of the audiovisual events that occur on different locations of the line – constituted by loudspeakers and LEDs. For example if a sound is heard on the most left loudspeaker, a luminous event is simultaneously visible on the left side of the LED line. If a sound is moving from the left to the right, through the four loudspeakers, a synchronized luminous event will also move from the left to the right side of the LED line. For a better understanding of this experiment please attend the audiovisual documentation available at: https://vimeo.com/317813704.

Asail

For xCoAx 2019 submission, the previous experiment will be re-designed in order to experiment between audiovisual asynchronism and synchronism as a possibility to expand an illusory sense audiovisual spatialization. This new experiment will be titled aSail – aSynchronous as in life. aSail is constituted by exactly the same hardware, with exactly the same placement, as in Sail, however the algorithm will be re-designed in order to introduce variable time latency between the visible and the audible. The intention is that this latency induces to a depth illusion. Instead of an audiovisual spatialization in a horizontal line as in Sail, it is expected that in aSail an illusion of audiovisual depth spatialization on an horizontal plane is achieved.

According to Bizlei et Al., crossmodal integration is a term applicable to many phenomena in which one sensory modality influences task performance or perception in another sensory modality. In our everyday life experience, almost all audiovisual events are in fact asynchronous due to the light and sound different speeds. When one is three hundred meters away from a firework show, the sound of the fireworks has a latency of around one second. This latency reinforces the perception of distance.

Let's imagine aSail inside a three axes cartesian space, the visual events can only vary on the x (horizontal) axis because the LEDs are aligned horizontaly and all of them have the same height and depth. From a crossmodal integration approach it should be possible to induce the illusion of depth by playing with the latency of audible stimulus to visual stimulus. For example if there's a white flash on the led line synchronized with a bass sound, this perceptual object could be interpreted as being closer than a perceptual object in which the sound would be heard half a second later than the flash of light. xCoAx 2019 seems a great opportunity to experiment and premier aSail.

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The Library of Nonhuman Books

Keywords
nonhuman reading
natural language processing
illumination
generative writing
installation

The Library of Nonhuman Books centres around a custom-made reading-machine which uses machine-learning to abridge and ‘artificially illuminate’ physical books through a combination of algorithmic interpretation and digital palimpsest. Newly illuminated texts are offered as alternative futures of the book. The project speculates on the book to come, where a post-literate society defers its reading to nonhuman counterparts.

1 THE PROJECT

Fig. 1.
The Library of Nonhuman Books
[reading machine], 2019.

The Library of Nonhuman Books is an autonomous reading system, intended to function as a “bridge” between human and nonhuman readers of books produced between the mid-15th and late-20th century.

At the heart of this system is a custom-made reading-machine which can interpret any page of text from a (physical) book placed in its ‘cradle.’ The machine algorithmically searches for combinations of words on the page in an attempt to create new derivations of the original text. These combinatorial results are revealed through the erasure of all other words on the page. Based on the resulting text, the system then searches online for an accompanying image that it uses to ‘illuminate’ that page.

The resulting spread is projected in real time into the exhibition space, allowing the reader to contemporaneously view both the original book (which lies within the machine) and its altered pages (projected onto the wall or screen). Automation of this system also permits the creation of new editions, which are occasionally printed, bound, and added to the Library of Nonhuman Books (Fig. 2). In addition to the reading-machine, a small version of this Library is exhibited.

Fig. 2.
The Library of Nonhuman Books
[Sample of printed Artificially Illuminated book], 2019

1.1 An Artificially Illuminated script.

This project creates a digital palimpsest, or scraping away, of texts, which are offered in the place of, or alongside, the original material book. Working within the genre of erasure poetry with the added disruption of 'illumination,' our reading-machine leverages artificial intelligence and machine learning to make and unmake meaning with every turn of the page (Figs. 3-5).

Significantly, the system attempts to perform its combinatorial functions while preserving the materiality of the book-object, including the physical texture of the book's support, and other para-textual elements such as page numbers and marginalia.

When a book is placed under the reading-machine, the system automatically and continuously generates new combinations of the printed text, and adds semantically related images taken from the internet. Through this process of 'artificial illumination' new meanings are proposed that, until that moment, have remained latent in the original work, not consciously perceived by the reader.

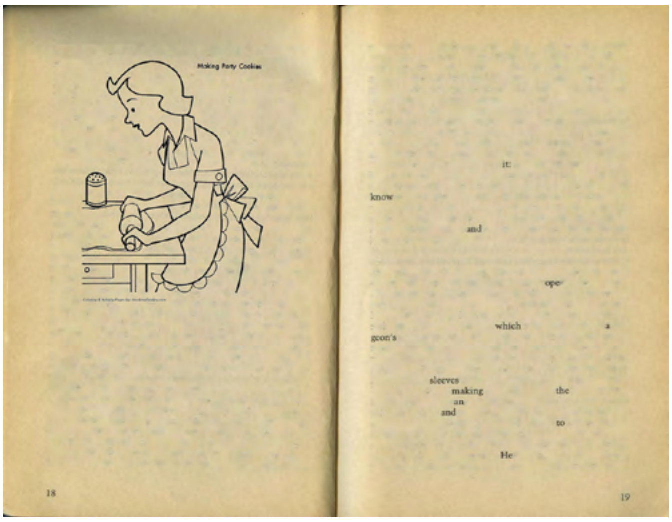

Fig. 3.
The Library of Nonhuman Books [spread]: "The Handmaid's Tale" (Illuminated), 2019. Spread from the algorithmically modified edition of Margaret Atwood's 'The Handmaid's Tale' (1995).

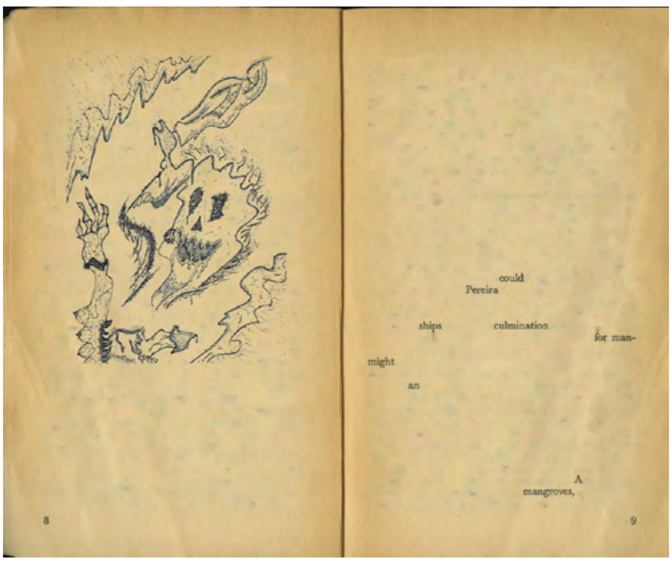

Fig. 4.
The Library of Nonhuman Books [spread]: "The Terminal Beach" (Illuminated), 2019. Spread from the algorithmically modified edition of J G Ballard's 'The Terminal Beach' (1966).

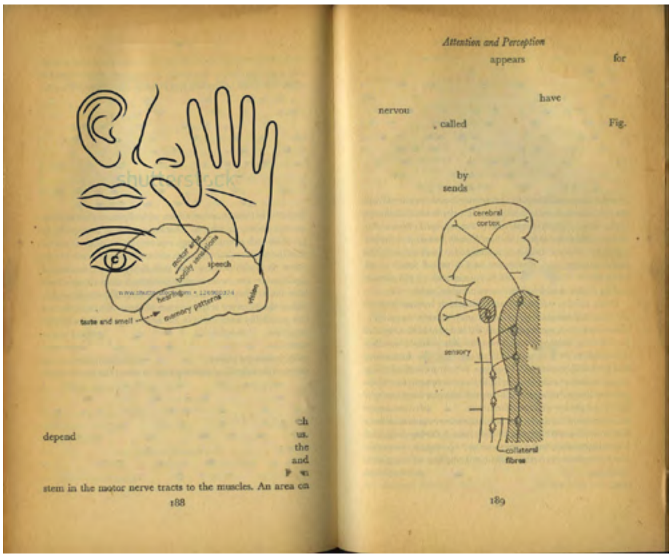

Fig. 5.
The Library of Nonhuman Books [spread]: "The Psychology of Perception" (Illuminated), 2019. Spread from the algorithmically modified edition of Vernon's 'The Psychology of Perception' (1962).

2 TECHNICAL DESCRIPTION

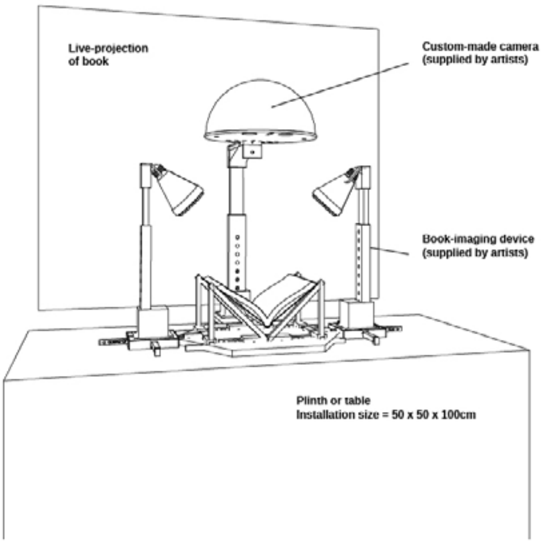

Fig. 6.
The Library of Nonhuman Books [installation diagram]. Reading machine, books and digital projection, 2019.

This Nonhuman Reading system is custom designed, and comprises a camera, a Raspberry Pi and a projector. The machine's camera 'reads' the book placed in its field of view, by way of an original Python script leveraging Machine learning and AI, with OpenCV and NLTK (Python Natural Language ToolKit). The algorithm parses, interprets, modulates and transforms the text by removing a substantial number of the words to leave a grammatically determined 'essence' of the original text in its original position on the page.

The reading-machine's default setting searches for a low-density syllable-based new reading for deriving semantic meanings, reminiscent of a Haiku poem. However, alternative scripted variations of our Natural Language Processing (NLP) -based system can be activated to further interpret the printed word through semantic synthesis (eg. abridgement) and/or lexical visualisation (eg. concrete poetry).

The remaining work is then ‘illuminated’ through the addition of a semantically associated line drawing sourced from Creative Commons Google Image search results, and projected in real time. Additionally, a selection of ‘pre-read’ books have been printed and are offered for perusal.

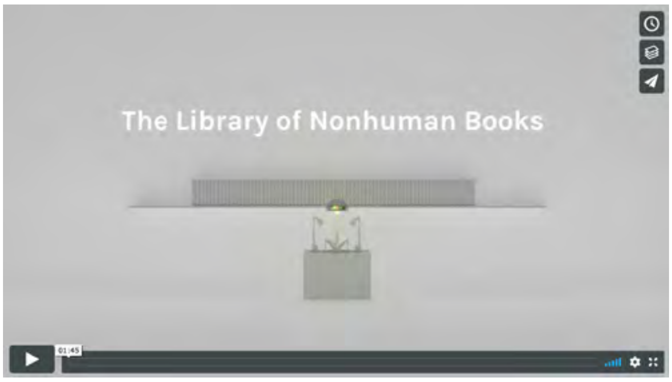

Fig. 7.
The Library of Nonhuman Books,
2019.https://vimeo.com/317774418

Acknowledgments

At the heart of this project, our custom-made human-machine reading system runs in Python on Raspberry Pi (Debian) and leverages open source libraries—Computer Vision (CV), Optical Character Recognition (OCR), Natural Language Processing (NLP), and Google Image API. We would like to acknowledge our support and appreciation of the authors and contributors of these projects. Additionally, Andy Simionato recognises RMIT University for research travel assistance. All media materials in this paper courtesy Karen ann Donnachie and Andy Simionato (Donnachie, Simionato & Sons), 2019.

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Regeneration of the Earth After Its Destruction by the Capitalist Powers

Keywords
artificial life
Anthropocene
capitalism
lateral gene transfer
HGT
adaptation
evolutionary art

Created in the belief that despite human abuses our planet will survive the Anthropocene, The Regeneration of the Earth imagines the renewal of life on Earth after the sixth extinction. The system models a synthetic ecology that begins in darkness as a toxic, primordial sludge. This hostile environment is seeded with an initial population of single sequence digital entities – brief, random strands of instructions – whose genomes use lateral gene transfer including conjugation, transformation, and transduction to evolve. Over generations, these entities may or may not advance their instruction sequences, but some will gain the ability to sense, move, mutate, replicate, compete, or co-operate. In Regeneration sensitivity to the environment acts as a universal fitness test. Entities that develop multi-species genomes can evolve their instruction codes to gain multiple sensitivities to co-habitants and to the world around them thereby increasing their chances of survival.

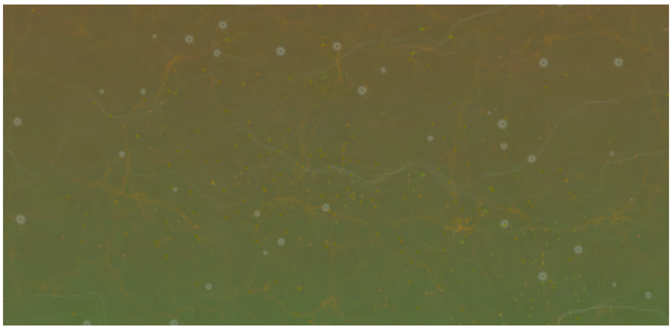

Fig. 1.
Regeneration of the Earth (2019), computer simulation, color/sound, infinite duration, screenshot.

1 DESCRIPTION

Regeneration of the Earth is created in the faith that -- despite environmental catastrophe -- new forms of life will re-emerge on the planet. The project proposes a second 'primordial soup', toxic and Plasticene, that coalesces after the ecosystem we currently think of as nature becomes extinct. This toxic sludge is seeded with a small number of primitive entities (Generation 0), each with a small set of instructions that allows their immediate existence, but does not guarantee their ultimate survival. The traits, abilities, and sensitivities of these base entities are controlled by their initial genome, a short set of instructions coupled with an execution operator that determines a base entity's starting state and neighborhood. Initially, base entities can evolve their genomes through mutation and, where allowed, through lateral gene transfer based on neighborhood. To persist, entities must combine with others in the environment to acquire the ability to sense change and to self-replicate. As entities evolve, the environment responds. In environmentally aware entities, conditions for survival are updated. Environmental sensitivity is the universal fitness test of the system. Awareness of changing survival requirements as signalled by the environment informs the operating orders of entities. Entities proceeding without sensitivities to their environment, their neighborhoods, or to the needs of other genomes lose the ability to carry out sensible operations. Without an effective sense of how to behave, these entities are unlikely to survive. At random intervals, a reaper function eliminates about one quarter of the entities in the population based on an environmental event such as unexplained elimination of a genome part or a random re-evaluation of the benefits or hazards of an operating order. Entities themselves are then left to repopulate the sludge with new generations.

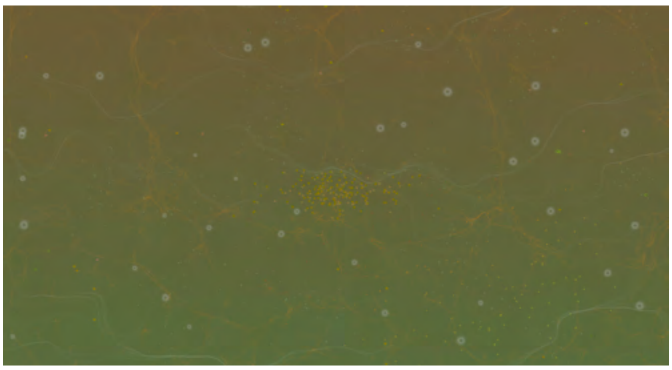

Fig. 2.
Regeneration of the Earth (2019), computer simulation, color/sound, infinite duration, plastiod swarming.

Initially, no entities have the ability to replicate. The genome allowing replication and the operating instructions guiding it must be assembled through mutation or through genetic transfer. There are several methods of genome transfer available to entities. Some entities can insert fragments of their genome into other genomes in their neighborhood (conjugation). Other entities can consume a neighbor's genomes (transformation). A third type of gene designation allows entities to take pieces from a neighboring genome and transfer it to another (transduction).

Entities can evolve or update their operating instructions in similar ways. Some entities can insert an operating instruction into a neighbor. Others can remove an instruction from a neighbor, alter the order of execution for a neighbor's instruction set, or delete a neighbor's execution orders entirely. Through these processes of mutation, transfer, and eventual replication, base entities may become creatures with the ability to move, sense. encase other entities, trade, fight, co-operate, and communicate, but these traits and abilities are outcomes of the system, not pre-ordained across entities by design.

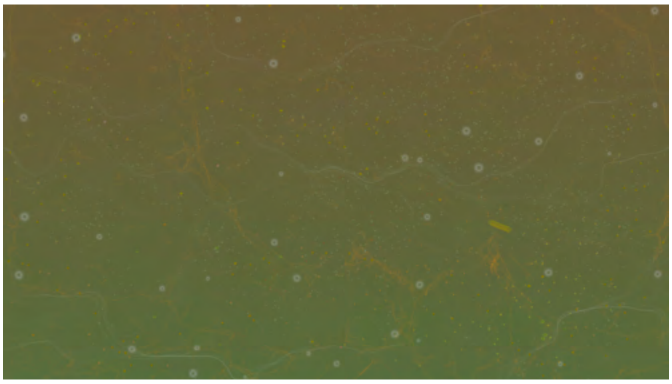

Fig. 3.
Regeneration of the Earth (2019), computer simulation, color/sound, infinite duration, bacteria blooms.

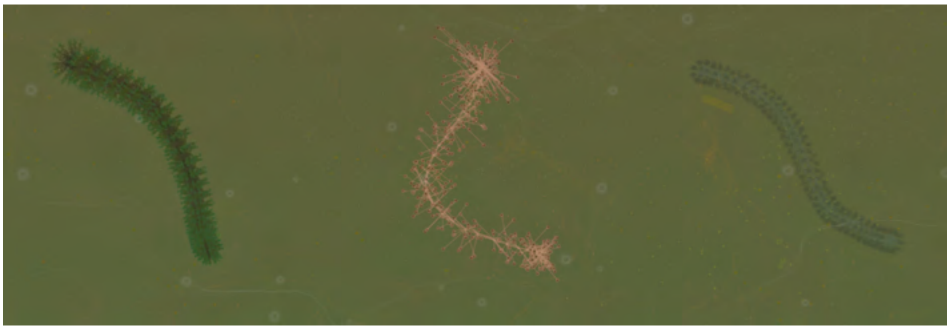

Fig. 4.
Regeneration of the Earth (2019), computer simulation, color/sound, infinite duration, detail..

On start up, the system is initialized with somewhere between ninety and a hundred digital entities, each with a short genome allowing it position, shape, and color. Genomes can be thought of as simple functions or lines of instruction to the entity. Genomes control an entity's appearance, but also an entity's lifespan, energy efficiencies, its ability to move, sense plastic or acid, and so on. Along with its genome, an entity is also constructed with a simple operator. Operators are simple indexing functions that determine and controls the order of execution of an entity's gene sequence. As entities mutate or exchange information with their neighbors, they are able to alter neighboring operating sequences as well. These four attributes: genome, operator, neighborhood, and lateral transfer allow entities to evolve. Entities do not need to mate to replicate and can exchange elements of a genome across their type or species. Since genomes allow action and sensation in the environment, entities with the greatest amount of variation in genome information are the most aware and resilient in their environment and therefore have the highest survival rate. Over generations, entities acquire the sensitivities and abilities of other species making them more likely able to survive shifts in the environment.

The last several years have made the global threat to our environment clear. Temperatures continue to rise. Species continue to disappear. *Regeneration* responds to this catastrophe by imagining an ecological future in which survival depends on environmental and community awareness. In this work, a toxic climate supports a number of genetic forms made up of several species. These entities replicate through the transfer of small bits of genetic material while using system feedback and adaptation to maneuver in a changing environment. While the simplest organisms have the most clear-cut goals, multi-species entities have a wider range of environmental sensitivities and system responses. When the fitness test for an organism is its ability to respond to environmental change, the organisms in the system should learn to react with great sensitivity. *Regeneration* is mean to encourage an aesthetic that prioritizes relationships -- those existing between organism and environment, between humanity and the planet, or between nature and cyborg. The work argues that based on these relationships some form of life will continue on the planet even after our extinction.

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FABRICA

Machines Looking at People Looking at Machines

Keywords
image culture
inspiration
mood board
design
aesthetics
Pinterest
AI
GAN
computer vision

A visual research about the influence of image based blogging platforms on the creative process.

The mood board has become a typical starting point for the current design process, eventually condensing a variation of images into a final product. While the number of circulating images is growing, platforms like Pinterest have made it their mission to analyze and index images based on a set of formal rules that connects users across the globe—amplified by reposts, follows and likes. However, the impact on visual culture of what is considered optimal by the engineers who create the systems to access these images is questionable. Are we really looking for something similar or are we looking for something different? This Project was first conceived at Fabrica Research Centre in Italy under the guidance of Sam Baron and Angelo Semeraro and financed in part by TAC Eindhoven.


1 INTRODUCTION

Can A.I. replace designers?
Design offices and trend forecasting agencies all over the world share a common object of interest: the mood board. Mood boards are diverse arrangements of images, materials and sometimes text that are intended to define a certain kind of style or concept desired by their makers. Eventually these collections of references are condensed into a final product that can ultimately become part of future mood boards themselves. With instant access to an enormous amount of imagery, the internet has become a main source for potential mood boards and thus inspiration for a wide range of designers. The most commonly used tools to search for imagery however, are far from being biased. Every image search adds an image to a dataset, every search means interest and every interest can potentially be answered with a product suggestion.

Image boards like Pinterest are shaped by the millions of users who upload and annotate a wide range of photographs, scans, drawings and other imagery-combined, this content creates a extremely valuable collection of visual culture. As it is common practice for social media platforms, Pinterest has chosen an advertisement based revenue model in order to offer the user a seemingly free use of their platform. As Jaron Lanier has noted on several occasions however, advertisement driven business models potentially entail attempts of manipulating their users in order to sell more products. In a way this is manifested in the very design of Pinterest's search engine which is based on showing the user what are looking for. This might seem obvious but users usually only buy what they like, so there is no reason to show them something they don't. This premise of positivity, which can be found on other platforms as well, becomes a kind of feedback loop between user and platform and the outcome is often times a lack of variety in the suggestions the platform makes. Of course a search engine that shows the user something completely different from what they are looking for isn't exactly useful but the way it currently operates illustrates the limits of a visually trained AI that makes decisions merely based on the preferences it was taught and is hence unlikely to think outside of its own box.

Pinterest itself is at the forefront of visual AI research, looking for new ways to index similarities, and categories with the ultimate goal of search optimization. At the same time, the recently developed Generative Adversarial Networks (GAN ′ s) make it possible to use the datasets used for object recognition in order to generate new imagery. The process seems similar to the mood board: a range of images is used as inspiration to come up with new combinations of color, shape and texture. However novel the results seem at first though, they are representations of their dataset, posing the question of how creative an AI can really be and what that might tell us about our own creative processes.

Leading graphics processing units producer Nvidia regularly sets new benchmarks when it comes to machine learning. In one of their most famous research papers of the recent past they describe a new kind of GAN that is able to produce high resolution images. The dataset they used as an example to train this GAN is a collection of millions of celebrity portraits. The resulting fake celebrities seem interesting at first, looking undistinguished and strangely familiar at the same time, but the more images one sees the less interesting the individual images become. The pictures merely show what a famous person looks like to a computer, but they don't show actual celebrities. Ceci n'est pas la célébrité.

The archetype of today appears to be many. We live in a time where the shape of manufactured objects is no longer necessarily bound to their means of production or their practical use but instead seems to be of a more arbitrary nature that relies on a wide array of styles and post-modern design statements. With so many coexisting styles it sometimes becomes difficult to find a meaningful relationship between a style and an object itself, as it is the case with the Portrait of Edmond Belamy, a picture generated by a GAN that was sold at Christie ′ s for $432,500 in 2018. The picture looks like the faulty attempt of creating something that looks like a 18th century portrait, a genre that could have presumably been chosen for no other reason than a well documented dataset. However, the mistakes the algorithm made are actually interesting to look at as they illustrate the attempts and failures to recreate something that looks human made. These kinds of mistakes can be described to have a style of their own, and similarly to what happened in glitch art, there are artists like Mario Klingemann who emphasize this style in their work. Style is temporary however, with the algorithms becoming better, less mistakes are made and the more likely it becomes that the results will become increasingly like the celebrities generated by Nvidia—objects merely referring to their own appearance and the way they were made but without any intent and without any reference to something outside of their own datasets.

In this project an “artificial designer” is trained on the most popular Pinterest boards featuring ceramic vases. The AI is used to generate shapes that represent the average style popular at the time of creation of the dataset. The generated vases are reproduced together with a professional ceramics manufacturer, photographed and ultimately fed back into the context they came from: Pinterest.

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Who's the Dummy?

Keywords
sound art
multimedia art
propaganda
ventriloquism
social media
bots

This work uses anonymously produced videos from right-wing propaganda channels on YouTube as material for a multichannel multimedia installation. Synthetic speech from the videos is sampled and disseminated spatially using a generative algorithm, producing a dialogue about truth and deception in digital communications. Accompanying video, prints, and texts contextualize such propaganda as ventriloquism, a practice in which a voice's ability to exert power is enhanced by its emanation from a place that is intentionally obscured. ***Who's the Dummy?*** **considers the weaponization of anonymity in social media and users' propagation of propagandistic messages as a type of ventriloquial performance.**

1 AUTOMATED DISINFORMATION ON YOUTUBE

Digital social networks now constitute a critical battleground on which political campaigns are fought. For many, this trend became more sinister in 2016 when activities surrounding the election of Donald Trump and the Brexit referendum showed that deception using social media had become an effective political tool.[1,2] Considering reports that progressive operatives in the US have also begun testing such tactics,[3] the future seems to promise an arms race in which online disinformation campaigns play a greater role in shaping and mobilizing public opinion.

One strange topography in this new propaganda-scape can be found on YouTube, where automated video channels generate videos based on texts from right-wing blogs.[4] With bland, deceptively ideology-free names like Headline News 24/7,[5] Top Stories Today,[6] or Hot News,[7] these anonymously administered channels aggregate partisan stories filled with disinformation, presumably to amplify their online reach. Aesthetically, the videos are flagrantly amateurish, laying out-of-context images over API-generated synthetic speech. At a time when the "mainstream media" is under attack, this lack of pretense to human accountability, journalistic professionalism, or the conventions of audiovisual communication is symptomatic of forms of online activity driven by alternative metrics of success, such as generating clicks, harvesting data, or distributing cookies that provide an infrastructure for tracking and expanding networks.

1. Alicia Parlapiano and Jasmine C. Lee. "The propaganda tools used by Russia to influence the 2016 election." *The New York Times*, February 16, 2018.

2. Matthew Field and Mike Wright. "Russian trolls sent thousands of pro-Brexit messages on day of Brexit referendum, Twitter data reveals." *The Telegraph*, October 17, 2018.

3. "Progressive activist defends his deceptive tactics." *On the Media*, January 11, 2019.

4. David Gilbert. "Pro-Trump robot videos are popping up all over YouTube — and no one seems to know why." *Vice News*, May 18, 2018..

5. https://www.youtube.com/channel/UC2-UjVm_wImBCybeV7SOxUw/videos

6. https://www.youtube.com/channel/UCSX7o6Dk3U_MGyEMhWRXl7w/videos

7. https://www.youtube.com/channel/UCS9AqsDrcYWLYAOXoGpvQRQ/videos

2 ONLINE PROPAGANDA AS VENTRILOQUISM

In *Who's the Dummy?* I propose that ventriloquism can provide a framework for thinking about these bot-generated videos, and social media propaganda in general.

Ventriloquism is a practice with a long history in which one individual creates voices that seem to belong to another.[8] Here, the relationship between a speaker producing the voice and the utterance is intentionally decoupled so that the utterance appears to have an origin that is not, in fact, true.

In conventional communication an auditor can typically identify the source of a message, an ability that is important for understanding. The uncanny power of the ventriloquist — and of the anonymous 21st century propagandist hiding behind social media platforms — comes from his ability to confuse this function. From online bot networks,[9] to Facebook pages representing nonexistent activist organizations,[10] to "astroturfing" campaigns bankrolled by wealthy political operatives,[11] recent history has witnessed numerous incidents in which online anonymity is weaponized to exert power. Social media now enables what we might call ventriloquism at scale, in which obscure voices thrown with political intent can reach large audiences.

The successful ventriloquial performance can have two possible effects. In one, the audience is deceived, perceiving something that does not correspond to reality. In the second, a situation that the University of Cam-

8. In this article I do not have space to discuss this in detail, though I can recommend Steven Connor's *Dumbstruck: A Cultural History of Ventriloquism* (Oxford University Press, 2000), which provides an impressive historical survey and theoretical framework for understanding ventriloquism, and which I found useful for thinking about online propaganda .

9. Philip N. Howard, "How political campaigns weaponize social media bots." (*IEEE Spectrum*, October 18, 2018).

10. Mike Glenn, "A Houston protest, organized by Russian trolls." (*Houston Chronicle*, February 20, 2018).

11. Adam Bienkov, "What is astroturfing and why does it matter?" (*The Guardian*, February 8, 2012). .

bridge's Steven Connor has characterized as "mediated self-hypnosis," the audience is aware of the illusion and suspends its disbelief to participate in it.[12] After all, we do not believe that the puppet at the ventriloquist's side is conscious; pleasure comes from allowing ourselves to be fooled.

12. Connor, p. 306-307. .

From this perspective, it would be oversimplifying to suggest only that devious forces are using social media to exert mind control on unwitting voters. Memes, blog posts, and perhaps even robot videos propagate because their messages resonate with certain audiences. However, the anonymity enabled by social media can promote confusion by complicating users' ability to assess the value of the information they consume and circulate, or the motivations behind its production. This confusion produces the additional anxiety that we risk becoming something akin to "dummies" through whom others speak.

3 THE ARTWORK

Who's the Dummy? brings content from the online propaganda videos described above into a public space, presenting it in the context of ventriloquism to facilitate discussion about their historical context, aesthetics, and effects in society.[13]

13. *Who's the Dummy?* was first presented at the generate!_lab Festival for Electronic Arts in Tübingen, Germany on November 10, 2018..

The centerpiece of the installation is a multichannel audio work, created using a Processing algorithm that randomly plays samples of robot voices from the videos. The samples do not recapitulate propaganda but have been selected for the ironic concern they express for issues of truth and deception in digital communications.

Video and prints thematize the audio in the context of ventriloquism. Video depicts close-ups of a mouth, which disjointedly ventriloquizes texts from the samples. Laptop computer monitors display slides containing text versions of audio sample content. Leaning against a wall are prints balanced on lengths of wood like makeshift signs for a political protest. Each is titled with the name of a video propaganda channel and presents a distorted image of a ventriloquist and his dummy. Below each is a redacted set of five thumbnails taken from the corresponding YouTube channel, in which the video titles are edited in ways that distort their propagandistic intent.

Finally, a booklet of readings collects texts contextualizing the videos, inviting thought about the nature of new communications media, deception at work in the darker corners of online political activism, and how concepts originating in ventriloquism can help interpret these new trends.

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Luciferina

Keywords
bioluminescence
cymatics
anthropogenic noise
audiovisual installation
vibration
particle motion

Luciferina **is a laser and sound installation that explores how noise pollution can affect the phenomenon of bioluminescence, a form of underwater communication through light emission. This audiovisual installation creates an immersive environment through a dialogue between sound and light exposed by vibrational phenomena, where the use of low-frequency sounds disturbs light visualisation. Cymatics can reveal another level of visual interpretation of sound allowing further comprehension of how vibration can interfere with light transmission. The input data is from underwater recordings, with a particular emphasis on motor vessels and propellers sounds. This installation aims to explore the concept of turmoil and disturbance in marine ecosystems. Moreover, it draws attention to anthropogenic noise in deep ocean environments, questioning their impact on organisms that may be affected not only by sound disturbances but also by changes in vibration and particle motion.**

1 DESCRIPTION

Two primary forms of communication are vital in the ocean: either the use of acoustic energy or the emission of light. The majority of marine animals interact with their environment by sensing sound, vibration, or acoustical energy. The information they get from the background noise allows them to reconstruct an image of the environment, *illuminating* these places sonically as they could "see their environment through sound" (Stocker 2013, 111). The other predominant form of communication is by bioluminescence[1] and is widely used in deep sea environments deprived of light, although it is also seen in many sea surface organisms (Harvey 1940). One of the responsible for the majority of surface sea light is the dinoflagellate *Noctiluca*. These luminous animals require mechanical agitation or some stimulation or disturbance to generate light.

1. A form of chemiluminescence in which special compounds manufactured by luminous animals are oxidized with light production (Harvey 1940, 121).

Cymatics was developed from early studies in resonance and was further explored mainly by Ernst Chladni, that used resonant metal plates and sand to reveal vibration patterns. These Chladni experiments ended up in the development of the Chladni figures (Figures 1-4). As today we are assisting an increase in researchers, scientists and artists that rely on sound or soundscapes to study and understand environments (Monacchi & Krause 2017), cymatics can help to unveil things that are usually not seen, and the growing knowledge about the negative impacts of noise pollution in marine animals requires a more conscient approach to underwater sound.

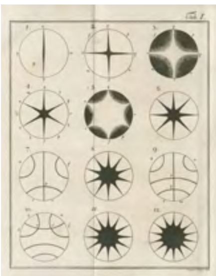
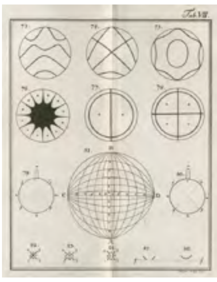
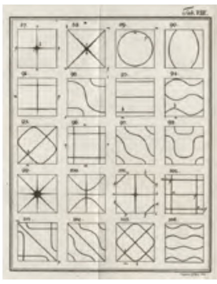
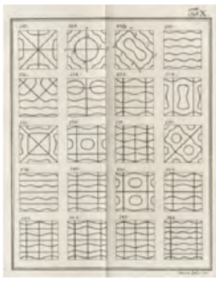

Fig. 1. to 4.
Chladni figures. In *Entdeckungen über die Theorie des Klanges*, 1787.[2]

2. Retrieved from https://publicdomainreview.org/collections/chladni-figures-1787/ accessed in 04.02.19.

For a long time in history that musical compositions use the presence of water connected to diverse kinds of artistic practice. Early examples include Jackson Pollock dripping techniques influencing water dripping music, where composers could use temporally the water drops sounds and organize them in terms of a score, or Luigi Russolo, that was probably one of the pioneers trying to reproduce water sounds with *Psofarmoni* in 1924, after realising that in nature, water represented the "richest source of noises" (Khan 1999, 246). In the same context, John Cage developed a series of works using water as the main element, such as in *Water Walk: For Solo Television Performer* (1959), a performance where he explored different objects revealing water properties. In *Double Music* (1941) he explored sounds of an underwater gong based on past experiments on providing musical cues to water ballet swimmers (Khan 1999). Since then, many artists incorporated sound, water or fluidity to their works, as well as started to introduce concepts such as chance, immersion or aurality (ibid). *Sonic Water* (2013) is a cymatics installation from Sven Meyer and Kim Porksen offering two experiences where the visitors can either appreciate the cymatics projections or be part of the process creating their cymatics (Figure 5 - 6).

Fig. 5. and 6.
Sonic Water. 2013.[3]

3. Retrieved from http://www.sonicwater.org/sonicwater.html accessed in 04.02.19.

Light Leaks (2013) from Kyle McDonald and Jonas Jongejan is a light and sound installation exploring reflection and patterns created by mirror balls and a projector. Moreover, by reflecting light in the room, they create immersive spaces challenging the visitor's peripheral vision (Figure 7).

Fig. 7.
Light Leaks. 2013.[4]

4. Retrieved from http://kylemcdonald.net/ accessed in 04.02.19.

Inspired by these practices, this project follows ongoing research that focuses on how to use ecoacoustics as a tool for environmental awareness, with a particular interest in the exploration of ocean soundscapes. The importance of sound as a component of an environment is studied by the field of ecoacoustics, that "investigates natural and anthropogenic sounds and their relationships with the environment over multiple scales of time and space" (Farina & Gage 2017, 1). It connects to the concepts of environmental stewardship, ecomusicology and eco-structuralism. Moreover, it describes not only the life characteristics of species, populations, communities and landscapes or waterscapes but also intends to understand the impact of anthropogenic sounds on these sites (Farina 2018). Ecoacoustics approaches can be considered a promising field to improve the link between sciences and art, providing the setting for artistic exploration of sound material.

In *Luciferina*, the exploration of sound disturbance aims to be a metaphor for the threat's marine organisms face nowadays. We use data collected from underwater recordings as input for artistic exploration on sound frequencies and light scattering relationships (Figures 8-11). In order to do so, we will be exploring the power of sound combined with light as an immersive medium, and concepts such as *aurality, presence, immersion*, or synesthetic *perception.* The installation consists of a laser projection in a plate filled with water. This plate has underneath a mirror and a speaker that is producing low-frequency tones, causing the water to vibrate in the plate. The mirror underneath the plate makes the laser projecting the walls, and the different frequencies create different visualisation patterns. The ideal set up for this installation is in a dark room with plain walls with the speaker and plate at approximately 1-2 meters from the front wall - the laser projector at about 1-2 meters from the speaker. The use of small additional mirrors glued on the main wall will enhance the spread of pattern visualisation in the other walls other than the main one, creating a disturbing environment through light reflections in the room.

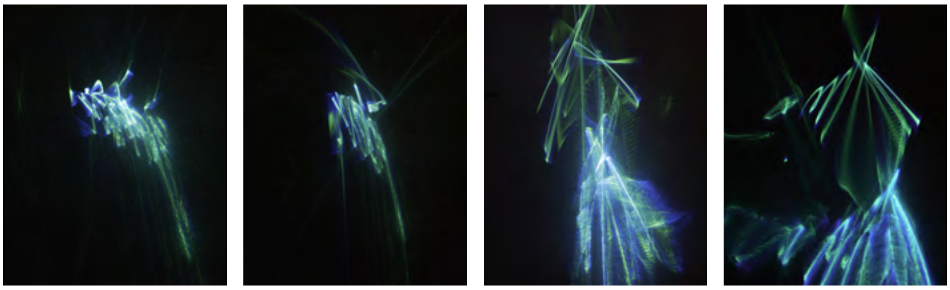

Fig. 8. to 11.
Luciferina patterns.

Acknowledgements

The authors gratefully acknowledge the financial support of "Fundação para a Ciência e Tecnologia" (FCT Portugal), through the research project SFRH/BD/134357/2017 ("Ecoacoustics as a tool for environmental awareness: the ocean soundscape").

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xCoAx 2019 Conference on Computation, Communication, Aesthetics & X Milan, Italy

“Forensic fantasies” - Artistic Remixing of a Global Data Breach

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Keywords
E-waste
Data Subject
Found Footage
Social Engineering
Artistic Research

Consumer electronics such as smartphones and notebooks have become an indispensable part of our daily lives. The Internet of Things (IoT) is increasingly adding electronic devices onto our shopping list. Devices that are adding up to a 24h surveillance system that are tracking every aspect of our life. The life cycle of these products is considerably short. Some obsolete devices end up in regulated e-waste centers in Europe, yet a lot of them are dumped illegally on electronic-wastelands in developing countries. A privacy issue is that these devices still contain personal data that can be reanimated and abused when falling into wrong hands. As a starting point to explore possible data breaches we bought hard-drives at the biggest West African e-waste dump and shared it with a network of international artists. In a research lab, artists and researchers explored what happens to our electronic waste, what kind of data traces are revealed of the hard-drives prior owners, and what environmental and privacy threats do exist. One of the outcomes of this artistic exploration is the artwork trilogy ‘Forensic Fantasies’.

1 INTRODUCTION

As we the KairUs art collective, guided by a local, visited one of the biggest and most toxic electronic-waste dumps in the world called Agbogbloshie in Accra, Ghana, we witnessed ongoing recycling processes such as arriving of containers from the nearby Tema shipyard, people reusing, repairing or recycling components. Due to a lack of technical equipment the recycling process was very limited and toxic both for workers and the environment. Almost all electronics had reached their end-of-life state. The devices were dismantled and components like power packs, batteries, CPUs, storage mediums, casings, motors and circuit boards were collected and sold in bulk. Parts that could not be used or sold landed on the ground from where teenagers were handpicking cables and PCB parts, or use loudspeaker magnets for collecting tiny metal parts. The aim of the scavengers was to extract precious metals like copper, gold, silver or aluminum from the dirt on the ground. Besides this physical separation of e-waste a few recyclers were reported to search for sensitive information on old hard-drives in order to exploit and harass the pre-owners. With a background in investigating (ab)use of technology we were curious to sample probe if it is actually possible to recover data from a hard-drive discarded at Agbogbloshie. For the experiment several hard-drives were acquired from various recyclers who were extracting hard-drives from desktops and laptops. Both 3,5” and 1,4” hard-drives were bought for each 10.- respectively 20.- Ghana Cedi (about €2.20.-/€4.40.-, Jan. 2019). In total, we purchased 22 hard-drives from different manufacturers, with a variation in year of production and storage capacity. None of the sellers could guarantee that the hard-drives were still functioning so the only possible control on site was to check that the hard-drive pins were not corroded or broken and that the drives were in an overall decent condition. In an artistic research lab data was recovered from 6 hard-drives. Several artworks were created using this data. In this paper we describe a trilogy of artworks created by the authors.

2 FORENSIC FANTASIES

‘Forensic fantasies’ is a series dealing with data breaches of private information. The first artwork of the series is called ‘Not a Blackmail’ and examines the possibility to extort the pre-owner of a hard-drive. (Figure 1) Besides finding sensitive data of the owner it is crucial to be able to contact the person to express one’s demands. From one hard-drive we were able to trace the pre-owner, further through social media platforms; we were able to locate his current employer and other contact details. Rather than blackmailing the person, we grew curious if it is possible to get in contact with this person. Therefore, the speculative artwork consists of one ready to be posted package, containing the recovered data and a letter directed to the pre-owner.

Fig. 1.
Not a blackmail
(Photo by: Janez Janša, Aksioma)

The second artwork 'Identity theft' of the series focuses on the phenomena of romance scamming. (Figure 2) Scammers conduct identity theft by scraping images in bulks of attractive people to create fake profiles on social media platforms and dating channels. The fraudsters pose to be in love with their victims and, after gaining their trust, lure them into advance-fee fraud payments, always hiding behind their fake identity. One hard-drive contained several images of attractive women that showed them in everyday situations. Due to our previous experiences of investigating online scams we suspected that the images were copied to this hard-drive to create and sustain fraudulent profiles and that the women were victims of identity theft. West African Nollywood films, mainly Nigerian and Ghanaian low-budget films, have their own way of dealing with the phenomena of romance scamming, which is a recognized problem in these countries. In this installation 18 of the fraudulent online profiles using the same images found on the hard-drive are combined with Nollywood found footage clips that thematize the topic of romance scams.

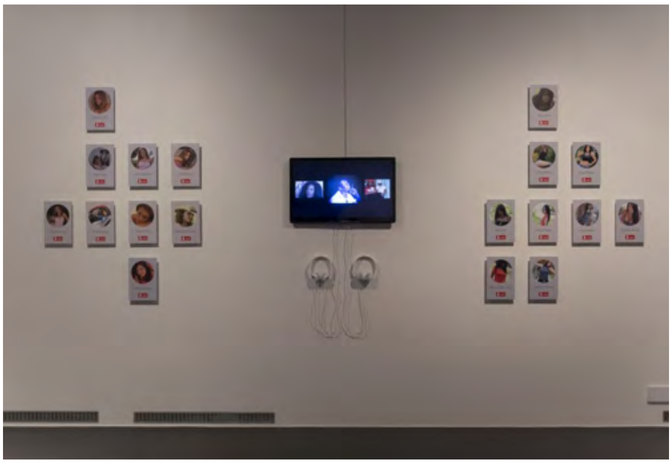

Fig. 2.
Identity Theft
(Photo by: Janez Janša, Aksioma)

The third artwork of the series 'Found footage stalker' (Figure 3) takes a closer look at the private images found on one of the hard-drives. Scanning through the private photos permits very personal insights into the lifestyle and habits of the pre-owners of this hard-drive. Over years we follow them to wild parties with friends, trips to amusement parks and private Christmas celebrations with their family. It is similar to the feeling of stalking someone unknown online, despite the rather uninteresting photo material, one starts to create stories and attach a personality to these fragmented digital representations. By presenting the photos in a classic photo album, the artists approach the material as 'found footage', ready for remixing and creating new artworks, something artists have done for generations. Hence the artwork confronts earlier practices of using 'found footage' with now digital materials found amongst our trash.

Fig. 3.
Found footage stalker
(Photo by: Janez Janša, Aksioma)

The 'Forensic Fantasies' installation reflects on how ones deleted or discarded data can resurface even when a hard-drive is believed to have reached its end of life. It brings forth the material aftereffects of our consumer electronics by presenting e-waste as sources of data breaches.

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Me, Myself & I

Mobile App as Interface for an Interactive Installation
http://marclee.io/en/me-myself-and-i
(Download the App for free)

Me, Myself & I" questions egocentrism and narcissism as widespread contemporary phenomena and their most popular, in-famous declination: the selfie culture. The digital era emphasizes the individual, who are seen more and more at the center of society, rather than being part of it.

Selfishness and narcissism are widespread, as selfie culture shows: We send mini-me's into the increasingly important virtual space of our society to make others aware of who we are and, most importantly, who we wish to be. Fiction, fantasies, exhibitionism, confessions, self-indulgent activities, solipsism motifs are the drivers behind our virtual life, with corporations and media shaping our (perceived) reality and exploiting recklessly our desires and fantasies, leading us further away from reality. The permanent representation of the lives of others also creates pressure to depict one's own life, which becomes a design object, and strengthens the spiral of staging through selfies and body cult.

This is where "Me, Myself & I" steps in and offers us an opportunity to develop new states of perception. In the virtual environment, images and reality are perceived unmistakably and unambiguously as being mutually incompatible. This helps the participant to decouple externally constructed realities from their natural environment.

The participant floats virtually in a self-absorbed ego-relationship with himself above an urban, futurist cityscape that is continuously regenerated. Users see themselves rapidly projected into the virtual environment countless times, as another way to replicate over and over again his ego. The virtual environment would be entirely dominated by his ego as translated by the selfies the tablet would take, that is, by the many images of his that would populate the cityscape. The virtual environment would rotate as the participant rotates the device with the sky showing up if the tablet is moved upwards. By tilting it downwards the ground appears. At the same time, the flight direction is adjusted and the flight speed can be changed. The sound is responsive and reacts to the movements and flight speed of the participant.

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Promenade Installation at xCoAx 2019

Keywords
Sound installation
immersive aesthetic experience
field recordings
aleatoric montage
anecdotal music
strollology
narrative identity

Promenade is a sound environment consisting of multiple tableaus suspended in space. Their arrangement hints at paintings in an art exhibition, but they do not show anything – each of them is a visually silent canvas. However, the tableaus become auditory images by means of two transducers mounted on one side. When a listener positions themself in front of a tableau, soundscape recordings projected by the canvas invite for an immersive listening experience. The entire environment provides a semi-narrative, anecdotal composition that emerges by strolling amongst multiple sound situations distributed in space.

1 DESCRIPTION

Promenade features multiple tableaus made from finnboard that are suspended in space. Their appearance resembles pictures or photographs in an exhibition. Instead of showing images, the material serves as a common membrane for both channels of a stereophonic sound projection by means of two transducers. Cross-talk cancellation is used such that the auditory image of the sound situation appears much wider than the visible, physical extension of the canvas. This effect suddenly occurs when taking up a centered listening position in front of the canvas and in a certain medium distance. The metaphorical notion of "entering" the image by enabling this projection technique is further supported by a distance-dependent narrowing of the stereo image even until monaural projection when listeners are far away or not in front of the canvas.

The entire installation of multiple tableaus unfolds an auditory landscape with several entry points to an open, associative narrative. This narrative is further determined by the structure of each of the compositions, whose playback is not synchronised. Most significantly, the individual trajectories of the audience when exploring the installation determine the auditory experience of the landscape. The underlying sound material consists of largely unprocessed field recordings carried out in different urban and rural surroundings. They embody mostly static sound situations of everyday life that may be regarded as momentary snapshots stretched out in natural time – there is not much happening in terms of a linear clear-cut narrative. The recordings focus neither on a temporal nor a geographical relation. They are selected and combined to qualify as distinct listening environments that feature anecdotal references and invite for aesthetic experience.

Promenade explores the qualities of monaural, stereophonic and cross-talk-cancelled sound projection on solid, sculptural surfaces. Reflecting on different modes of regarding a painting, auditory experience shall range from an incidental sonic occurrence over "framed" spatiality restricted to the projection medium up to an immersive appearance that exceeds the physical dimensions of the canvas.

2 BACKGROUND

Promenade has been conceived as a dispositif for enquiries into three scholarly and artistic areas: those of anecdotal music, strollology or promenadology, and narrative identity. *Anecdotal music* as coined in the 1960s by French composer Luc Ferrari contrasts Schaeffer's concept of an *écoute reduite* (reduced listening) by explicitly exploiting source bonding, the recognition of the sounds' origins and connected associations. *Strollology* aims at extending environmental awareness by studying uncommon modes and techniques of perception, namely those enabled by slowly walking through the observed field. While this "minor subject," as its founder Lucius Burckhardt put it, was mostly visually oriented initially and has been incorporated in cultural studies, architecture and urban planning, strollology has been further extended to the auditory domain in sound and listening walks. Finally, *narrative identity* as a discipline of psychology investigates self-construction by means of telling stories. Narrative fragments derived from everyday life experience are constantly negotiated with our social surrounding such that personalities are constructed, acknowledged and incorporated.

Fig. 1.
Promenade installation, *NeMe Arts Centre*, Limassol/Cyprus, July 2018

3 TECHNICAL REALISATION

Promenade uses minimal electronics for distance sensing and embedded computing for reactive signal processing. The installation is realised using the Supercollider audio language running on one Beaglebone Black per tableau equipped with a *Bela audio cape.*[1] One of its ADC inputs receives the voltage signal of the analogue optical distance sensor. The crosstalk-cancellation filters applied here were developed by Edgar Choueiri (Choueiri 2010) and are taken from the free and libre *Jconvolver* software package by Fons Adriaensen.[2]

1. https://bela.io/

2. http://kokkinizita.linuxaudio.org/linuxaudio/

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alt'ai: designing machine-to-machine interfaces for automated landscapes

Keywords
authentication
agent-based simulation
operational images
sentient machines

alt'ai **is an agent-based simulation inspired by aesthetics, culture and environmental conditions of Altai region on borders between Russia, Kazakhstan, China and Mongolia. It is set into a scenario of remote automated landscapes populated by sentient machines, where biological species, machines and environments autonomously interact to produce unforeseeable visual outputs. It poses questions of designing future machine-to-machine authentication protocols, that are based on use of images encoding agent behaviour. Also, the simulation provides rich visual perspective on this challenge. The project pleads for a heavily aestheticised approach to design practice, and highlights importance of productively inefficient and information redundant systems.**

1 DESCRIPTION

One of the main effects of the increasing diversity of machine species in our epoch is slow but dramatic change in the composition of Earth's landscapes. What we used to call "nature" has become populated by artificial objects: small and large, pervasive and ubiquitous, moving and standing, swarming and looming. Today, this transformation has culminated in the emergence of automated landscapes. Populations of sentient machines are taking over not only our cities, but also remote locations, not meant to be visited by humans — and if visited, then just by way of accident or curiosity. These new landscapes are still waiting to be properly imagined and visualised and on top of that, they pose some unprecedented design challenges. In particular, one may ask: What are the strategies of machine-to-machine interaction in these contexts? What are the address and identity protocols suitable for such automated environments?

Fig. 1.
alt'ai

In order to provide provisional answers to these questions, we decided to build a simulation. We call it *alt'ai,* and it is inspired by the rich aesthetics, landscapes, and cultural practices of the remote Altai mountain system, stretching over the borders of four countries: Russia, China, Kazakhstan and Mongolia. The simulation itself is an agent-based, self-evolving and complex system. It develops within a feedback loop between agents, behaviours (called rituals) and environments extracted from the Altai region. As a visual meditation, alt'ai makes an allusion to the rules of visual perspective in automated landscapes. As a self-generating repository of unique snapshots that capture instances of interaction among the agents in the simulation, it provides instrumental reference for the development of future machine-to-machine interaction protocols.

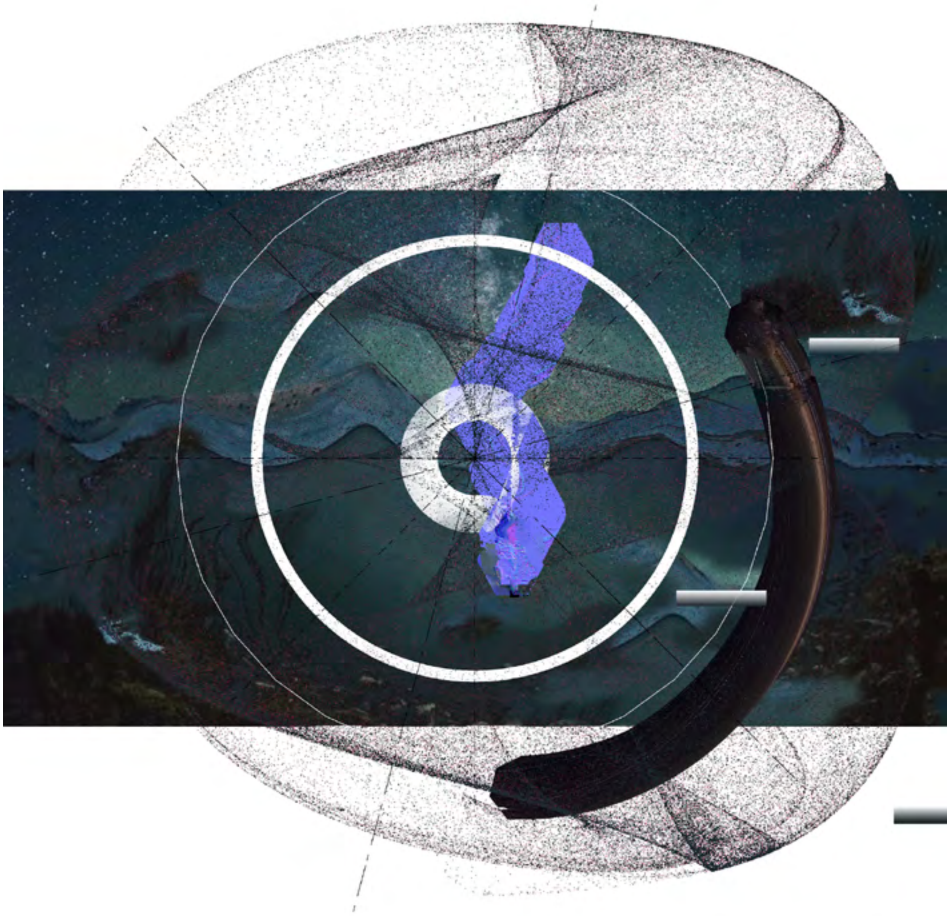

Fig. 2.
cosmogram

The main visual outputs of the simulation are called cosmograms. Beside providing the interface for simulation, they serve as a sort of dynamic and aestheticised IDs of agents, since they are literally drawn by agents' footprints in their mutual interactions. On the level of general 2D overview of the simulation space, the map of the all interactions within this little universe is called metagram. Evolving in five stages, the simulation matures and offers immersive 3D scenic snapshots of particular interactions called rituals. Rituals are derived from simple biological behaviours, machine information-processing and cultural practices coming from Altai region. In total, there are nine types of rituals, ten types of agents and seven types of environments (e.g. glacier, tundra, alpine meadows, swamp forests, prairies,...) in which agents can execute different rituals. Regarding agents, they come from research on adaptive evolutionary strategies (influencers, predators, couples, isolation agents,...) and also refer to basic environmental building blocks (elementals and generic agents) and AI-driven technologies (sensors and recognition agents).

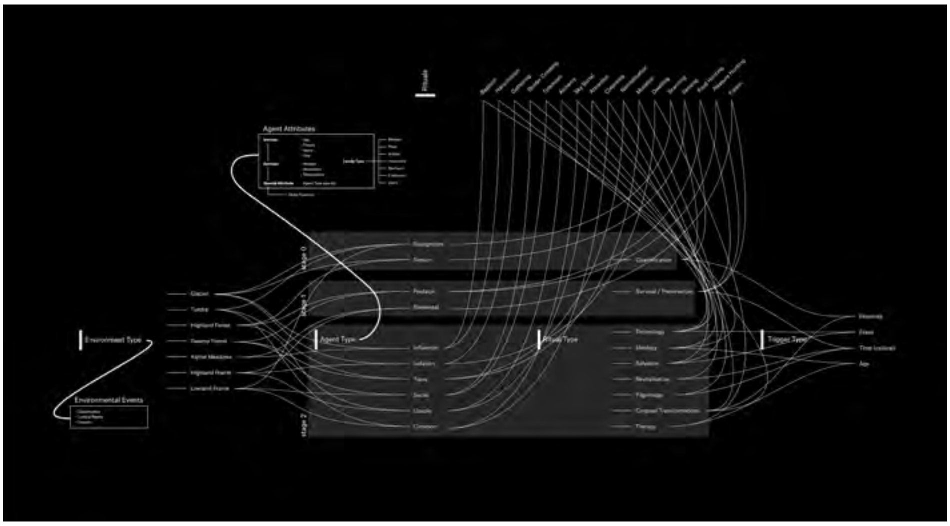

Fig. 3.
organigram of the simulation

The motivation to build a simulation was informed by design questions implied by Cambrian explosion of autonomous machine species slowly but dramatically populating Earth's environments:

How to design address and identity layers for automated landscapes?

How to design protocols for machine-to-machine interaction in these landscapes, especially regarding authentication protocols?

Finally, is it possible to use operational images (Farocki 2001, 2003) as instruments of authentication?

These questions are answered via notion of cosmograms that serve as reference for creating future aestheticised authentication devices, and by notion of platform animism as general ontology of our simulation, applicable to upcoming ecology of sentient self-evolving machines, that adapt to their environments on their own, communicate on their own, and engage in games of mimicry, camouflage and display. Crucially, animist ontology treats each entity as equal part of shared generic space of interiority (e.g. spiritual realm), since entity is individuated by means of its physical/corporeal appearance. Once secularised, we can say that each entity is endowed here with minimal subjectivity emerging in the situations when entity becomes a temporary locus of some chain of interpretation of signs in signalling games within given ecosystem: i.e. the process of semiosis as described by Peirce (1894) and Kohn (2013). Referring to existing protocols of authentication, the question 'who am I' in the animistic address space is universally answered by User triumvirate of what any entity is, has and knows (Bratton 2015).

alt'ai is not just a visual meditation that lives its own life of artificial object on the borders between software engineering, design, data visualisation and philosophy. As mentioned in the introduction, it tackles the bigger question of designing machine-to-machine interaction protocols in automated landscapes. Since cosmograms present imprints of agents' behaviour, we can view them as their aestheticised and dynamic IDs. Now, imagine that you run a simulation like alt'ai in the wild. Its purpose is clearly defined: it makes pictures that can be assigned to agents at different scales in automated landscapes in order to provide them the means to prove their identity and proceed with their tasks in mutual interaction. Authentication protocols based on use of cosmograms would even have the potential for universality, transcending national borders and regional jurisdictions — that is one of the motivations for our reference to the Altai region, which is divided between four countries with sometimes clashing policies. On top of that, as far as it would be based on self-evolving agent-based simulation, this protocol would be managed by itself without the need (and preferably even the possibility) of human assistance. Here, we enter the space of a larger discussion about the design of identity layers, address spaces and sovereignty.

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evoColorBox

Keywords
artificial intelligence
AI
genetic algorithms
evolutionary computing
color
color theory
generative art
cellular automata
physical computing

evoColorBox is a small light sculpture that visually evolves optimal color palettes. Standard rules for color harmony provide a fitness function heuristic. Borrowing notions from cellular automata, a population of competing color palette chromosomes is presented as a playful field of moving colors converging on a new palette. It starts with random genes, evolves for about 15 seconds, pauses, and then starts again. evoColorBox steps through the 16 color palette chromosomes displayed as 16 columns in genetic competition with their nearest neighbors. If a neighbor has a higher fitness score, a random neighbor color gene replaces its own.

1 DESCRIPTION

The field of generative art offers numerous methods for composing and realizing images, videos, music, performances, environments, and so on. But human artists typically work within a feedback cycle of creation, critique, more creation, more critique, and so on. Generative art for the most part doesn't automate the evaluation aspect of human artistic practice.

In particular, evolutionary computation, genetic algorithms, etc. have been hobbled by the lack of fitness functions that measure aesthetic quality. Because aesthetic fitness has yet to be automated, putting an artist in the evolutionary cycle as a manual fitness function is required. This creates the so-called "fitness bottleneck."

In addition, even though artificial intelligence in recent years has focused on specific advances in deep learning, approaching AI from the implied point of view of optimization has been less robust.

This artwork, evoColorBox, combines these two concerns by using a heuristic for color palette evaluation as a fitness factor. This allows the intelligent creation of effective color palettes using a fully automated genetic algorithm.

evoColorBox is a small light sculpture that visually evolves optimal color palettes. Standard rules for color harmony provide a fitness function heuristic. Borrowing additional notions from cellular automata, a population of competing color palettes is presented as a playful field of moving colors that converge on optimal palettes. Each performance starts with entirely random genes and usually takes about 10 to 20 seconds to evolve, and then a new performance begins.

evoColorBox displays 16 color palette chromosomes shown as 16 columns that are in genetic competition with their nearest neighbors. If a neighbor has a higher fitness score, then one of its color genes will be substituted in the chromosome in question. If the chromosome in question is more fit than either neighbor it will attempt to improve itself via mutation. Mutations that would lower its fitness score are rejected.

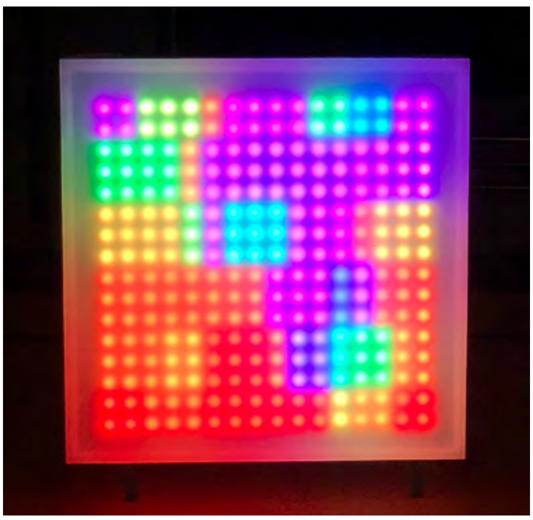

Fig. 1.
evoColorBox

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Stripes

Keywords
sound installation
sculptural loudspeakers
feedback
non-standard sound synthesis
generative music

"*Stripes*" is a sound installation that combines algorithmically generated music and piezoelectric film speakers. The sound synthesis method is based on a non-standard form of digital waveguide synthesis that consists of a feedback system with four delay lines. Unlike standard forms of digital waveguide synthesis, the four delay times are not fixed but vary over time independently from one another. Their constant changing gives rise to different timbres and rhythmical textures. Through their appearance as transparent and lightweight objects, the piezoelectric film speakers de-emphasise their function as sound emitting devices in favour of establishing a sculptural and poetic setting.

DESCRIPTION

“Stripes” is a sound installation that consists of four strips of a piezoelectric, sound-emitting film. Each film is 1.8 metres long and hung from the ceiling with its lower edge suspended at about 1 metre above ground. The sound synthesis method employed for this sound installation is based on a non-standard form of digital waveguide synthesis. It consists of a feedback system with four delay lines. The four delay times vary individually over time which leads to the emergence of a variety of continuously changing timbres and rhythmic gestures. Daniel Bisig realised the design of the installation and Philippe Kocher programmed the sound synthesis.

Piezo Films

The film speakers used in the sound installation “*Stripes*” are made from piezoelectric material, which allows them to act as sound transducers. Apart from their function as sound emitting devices, the piezoelectric films are also essential components for establishing the visual appearance of this sound installation. Being thin, transparent and weightless, they possess several material properties that stand in stark contrast with those we associate with traditional loudspeakers. Therefore, the films are not perceived as loudspeakers but rather as sculptural objects. As a result, the room is filled with sound that emanates from seemingly invisible speakers. This creates a confusing yet poetic effect.

Feedback Systems

The use of feedback and delay is commonplace in electroacoustic music (Sanfilippo and Valle 2012). The Institute for Computer Music and Sound Technology ICST explored the musical potential of time-delay and feedback mechanisms organised in networks (Bisig and Kocher 2017). These mechanisms can exhibit self-organising behaviour and generate often unpredictable sonic output. In addition, the manipulation of the network topology or of the delay times provides a formalism for algorithmic composition.

The sound synthesis method that drives the audio output in this sound installation is based on a non-standard form of digital waveguide synthesis that consists of a feedback system with four delay lines (see Fig. 1). The four delay times vary over time, and they do so independently from one another. As opposed to standard forms of digital waveguide synthesis, this approach is not intended to model an existing physical property. Instead, it permits to shape the timbral as well as temporal properties of the sound within the same formalism.

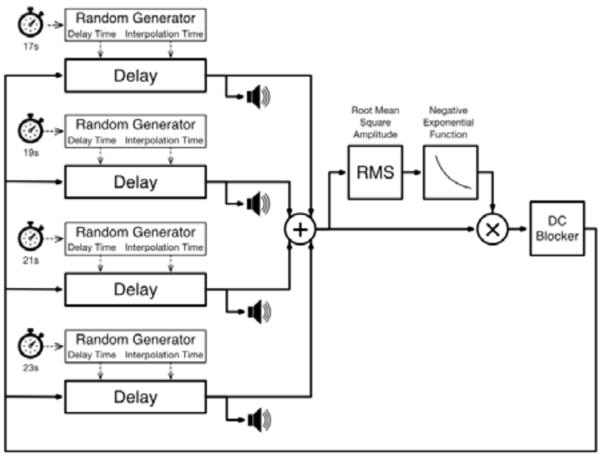


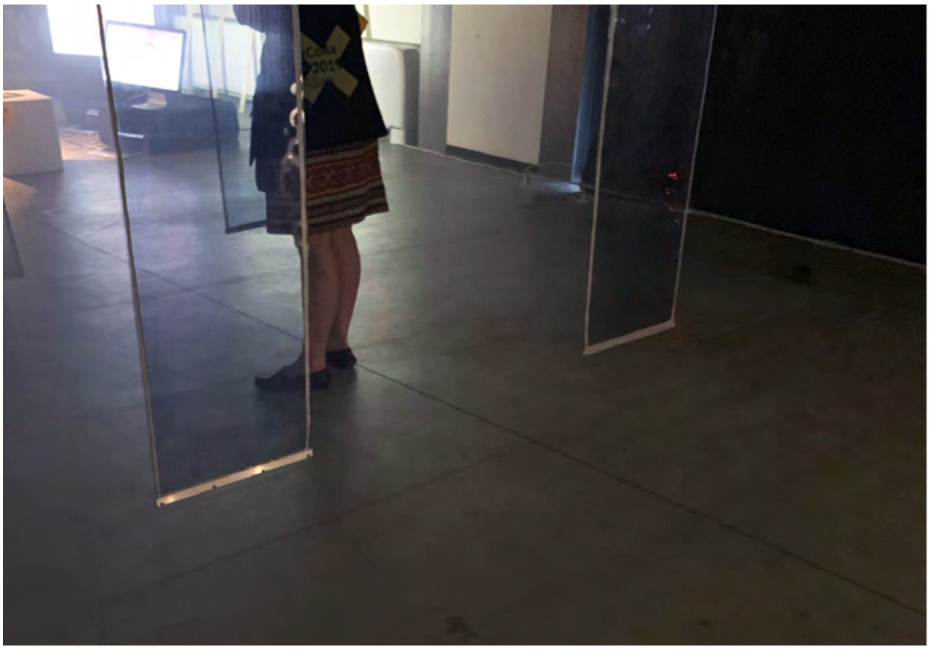
Fig. 1.
Flowchard of the feedback system used for the sound synthesis

Fig. 2.
Exposition in Zurich in 2016

Due to the presence of feedback loops, this sound synthesis system is self-sustained: Once excited with a short audio signal it continuously keeps on sounding. Two control mechanisms inserted in the signal flow prevent runaway conditions: an automated gain control and a DC-blocker. The delay times affect the resulting sound in different ways:

- Short delay times are responsible for timbres and perceivable pitches because of the comb filter effect that they impose on the signal.
- Longer delay times generate rhythms and spatial effects as the same sound events appear in all four speaker films at different times.
- The ramping up or down of delay times produces a change of pitch very much like a Doppler shift. The extent of the pitch change depends on the duration over which the delay times are interpolated.

Each delay line is controlled by a random number generator which, at regular time intervals, generates a new delay time and duration of interpolation. This control mechanism is quite simplistic. The sonic result, however, is rich and diverse. The emergent nature of this sound synthesis method originates from the complexity of the feedback network and the fact that the delay times influence different aspects of the sound (pitch, timbre, rhythm) at the same time.



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Performances

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LASER DRAWING a synesthetic experience in which you can listen to what you see, and see what you listen to

In *Laser Drawing*, I use my modular synthesizer to control electric voltages, that I send in the exact same way to the speakers to create sound, and to the laser to generate curvy shapes and vivid colors. It's a simultaneous creation of abstract images and music from a common source:
A completely analog audiovisual improvisation that binds audio and light in such a way so that the audience can more deeply read sound from light, thus listen.

NON-SYMBOLIC VISUALIZATION

The digitalization of video and the diffusion of affordable laptop computers in the last decades contributed to a multiplication of audiovisual performances in which images are superposed to sound to create an immersive sensory scene for the audience. Very often the two mediums are connected thematically but not in their generative processes. In the last years faster computing machines made it possible and particularly attractive to create synchronized audiovisual shows in which sound and image are more closely connected [1, 2]. These works use *symbolic* music visualization: arbitrary shapes are associated with a specific sound event. For example a big white square can appear on the beat of the kick drum or a red circle on a snare-type white noise burst.

I define the association I use for *Laser Drawing* as non *symbolic* because I make no choice in the translation of the sound signal into image: it's an unaltered one to one relationship, that is also often called *Visual Music* [3].

ANALOG LASER CONTROL

Laser is a beam of highly collimated light produced by optical amplification that creates a single intense dot. A shape is generated by deviating the laser dot using two mirrors mounted on two voltage-controlled galvanometer engines, one for vertical and one for horizontal shift. When these deviations are fast enough, our visual system integrates them and we perceive them as shapes. Galvanometers and laser intensities can be modulated with analog signals but normally a digital box is sold together with a software that allows the creation and sequencing of predetermined shapes and color modulations for commercial purposes.

To maintain the closest possible correlation between image and sound I decided to use only analog circuitry. Thanks to a custom-made cable, I can stream 5 channels of electric voltages to the laser ILDA cable and control X, Y deviations and R, G, B color levels. This allows me to bypass the latencies connected to digitalization and its quantized resolution (and the predetermined software shapes or aesthetic limitation), and allows me to build a personal performative architecture.

Because of the analog nature of my system, I have to embrace its intrinsic limitations as well: the whole show uses no presets, nor predetermined sequences and requires handmade tuning of oscillators with their respective phases. This aspect slows my transition time from one state to the next because I need time to adjust each potentiometer. I found that this adds a sense of artisanal freshness to the show and the audience has the time to recognize the effect of every change, both in sound and visual, keeping them connected during the performance.

The main advantage, thanks to the immediacy of laser control by electrical voltages, is that I achieve a totally different aesthetic compared to the common laser shows that use the digital box. For example, instead of the static horizontal or vertical scanning planes with fog typically seen in a disco laser show, I can create complex shapes, 2d Moiré patterns, or generate 3d models that don't require the use of fog.

Thanks to analog signals, free from frame-rate constraints, I can trace each image multiple times. The internal analog noise adds variability and organicity to the shapes. As a result, movements of shapes show a striking fluidity, very different from the usual examples we observe in the digital domain.

In my studio, I also experimented with a computer and a sound-card to send voltages to the laser. The use of a sound-card allows for higher sample rates compared to the commercially available laser softwares and hardware digital converters. The dedicated laser softwares with their digital boxes typically generates 25-60 frames per second, while sound-cards reach 192.000 samples per second: a much higher resolution that better approximates the results of analog circuitry. In this case, each user can program his own software for real time audio to control the sound generation, such as Max/MSP, Pure Data, Supercollider, etc. The sound-card has to be DC-coupled to allow creation of constant values.

VECTOR GRAPHICS SONIFICATION

The use of XY coordinates and formulas to create shapes is often called Vector Graphics in contrast to Raster Graphics in which pixels are used to compose images. The appeal of vector graphics may derive from the seemingly infinite resolution, the infinite line-based aesthetic, and the intrinsic impermanence of the display. Other motivations lie in repurposing obsolescent hardware (oscilloscopes, lasers), reimplementing historical devices (CRT monitors, modified Vectrex screens), or simply diverging from mainstream approaches to video. It is hypothesized that vector displays fell out of use when computers lacked the power to fully exploit them and that this limitation no longer applies. The use of only two signals limits the amount of variables necessary to create a shape. At the same time, the vocabulary is limited to the complexity and creativity in the signals one generates.

Many audio tools are well suited for vector graphics as both need complex timed control of multiple parameters. The wide range of creation/performance methodologies allows varying degrees of audio/video correlation. At one extreme, visuals may be independent of the audio, as in non symbolic audiovisual performances. However, audio seems the perfect tool for the simultaneous synthesis in both the visual and auditory domains.

In *Laser Drawing*, I use the X and Y signals that build my shapes and plug them directly into the left and right speaker for sonification. In this way, the audience listens directly to the shape part of the signal. I rarely sonify the three color signals R, G, and B.

The use of vector graphics is not a new artistic nor scientific practice. Early experiments building vector synthesizers for oscilloscopes date as far back as the 70s [4, 5, 6]. Those experiments were also applied to lasers and used sonification of the generative signal in some cases [7]. What is new in the case of *Laser Drawing* is the possibility to have them generated live using a full analog setup. The recent availability of compact electronic circuitry makes it possible to transport what was in the past a whole analog studio, to the context of a live performance. The relatively low cost and compactness of recent lasers made it also possible to have laser shows of visual music using multiple lasers controlled by computers [8, 9].

A quick experimentation with different signals shows immediately how harmonic ratios between X and Y signal frequencies typically give the most stable shapes, that otherwise approach chaotic behavior. Two sinusoids at unison (in quadrature) create a circle, while an octave (2nd harmonic) appears as a two lobed shape, a fifth (3rd harmonic) generates three lobes, etc. The Pythagorean theory of scales and intervals is a good starting point for the artist in this field. Laser Drawing uses this principle of generation: from simple to more complex, allowing the audience to progressively familiarize with the cause-effect connection between sound and image. It builds more and more complex associations, starting from a circle and moving towards angular shapes with multiple lobes by adding harmonics, and from static signals to rhythmical amplitude modulations which manifest into shapes enlarging and contracting depending on sound intensity. I implicitly build a dictionary of associations for the audience, which expands continuously from the beginning till the end of the show.

Another interesting remark concerns the concept of beauty: a perfect harmonic tuning between X and Y produces static shapes [10]. Introducing a slight detuning of less than a Hertz makes every shape move softly, generating a pleasing ear and eye massage (audio-visual beats). It suggests that beauty requires proportion combined with slight imperfections to make it non static and continuously interesting.

AUDIENCE PERCEPTION

Thinking from the audience side, there are several levels on which one could interpret or approach the performance. The first most intuitive approach is the superficial appreciation of the shapes created with shiny colors of laser light. Most audiences after the show are “surprised on how one can do such things with laser” being accustomed to the regular club laser show that uses a combination of either planes or standard symbols (hearts, stars, triangles) , written text using rainbow colors.

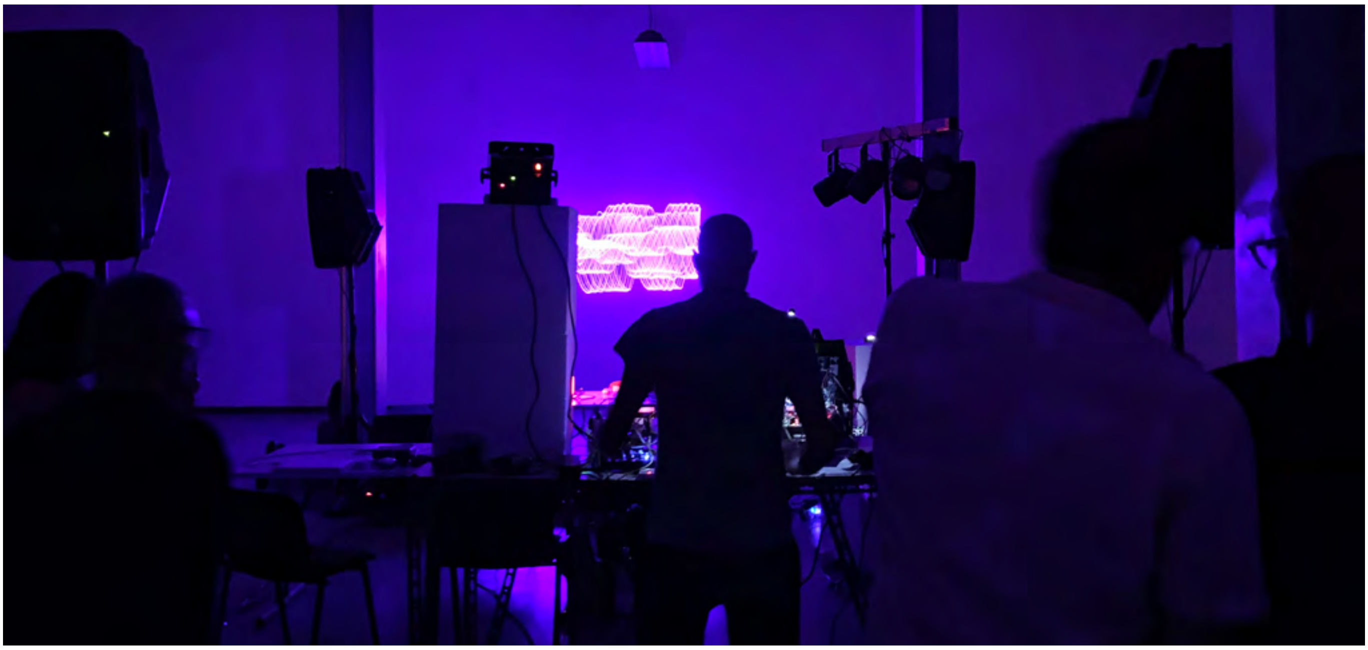
On a second level audiences are interested in the performative aspect of manufacturing laser shapes in real time using a limited set of knobs and circuitry. This is rarely visible at a hand’s distance, as lasers are usually rigged in a black room somewhere remote from the audience. Instead, I position myself in the middle of the audience and the public appreciates the aspect of viewing my actions and choices, starting from my physical body and continuing into the projected light and sound.

A third level concerns the complete synchronization of image and sound. This allows audiences to remain entertained by unfamiliar sounds [11]. The presence of shiny moving light shapes makes the audience more receptive and they simultaneously get accustomed to new sound palettes while developing reflections about sound and its proportions. This creates a total true synesthetic experience for the audience that connects their senses, forming a cognitive gestalt unity between sound and vision, similar to the case of auditory scene analysis [12]. They especially verbalize this aspect in regards to the last part of the show, with more rhythmical and percussive sounds.

Laser Drawing is audiovisual composition based on a non-hierarchical and hence bi-directional relationship between sound and image. It does not represent a visualization of music or sonification of an image but rather emanates from an audiovisual paradigm that is based around the idea of intertwined audiovisual interactions. The result of this is the ability of both modalities (sound and vision) to modulate the meaning of each other on the level of perception, hence in very abstract and subjective ways as our brains always try to fill the gaps between sound and image in order to make sense of the world.

I am deeply convinced that the simultaneous and unprocessed translation of audio signals into video (especially in the analog case) is a perfect tool to deepen one's listening abilities. The micro variations in the waveform become even more apparent thanks to the visual domain and the listeners discover what they're already unconsciously hearing in the audio domain: beating, filtering, distortion, etc. It is still unclear whether this phenomenon is linked to the priority we give as society to vision over hearing or if this is just the phenomenon of intermodal coupling that reveals more details in the signal than what we could normally perceive with the individual senses [13].

Each time I try to categorize this phenomenon, I find myself extending Pauline Oliveiros' [15] idea of deep listening by defining my performance as *visual listening*. This simultaneous audiovisual attention is, in my opinion, the main contribution of my field of work: beyond the attractive aesthetic results, I hope to encourage people to venture into uncommon or unusual sounds while exploring their shape through their eyes and ears.



LINKS

small video snippets: https://www.instagram.com/_jestern_/
full audiovisual pieces: https://vimeo.com/240737144, https://vimeo.com/207104522
typical live setup: https://vimeo.com/235351838

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Bad Mother / Good Mother an audiovisual performance

Keywords
technofeminism
audiovisual performance
breast pump
motherhood
politics
physical computing

Bad Mother / Good Mother is an audiovisual performance involving a projection, a modified electronic breast pump as a sound generator, and a sound-reactive LED pumping costume. The project has four songs that critically explore technologies directed specifically at women like breast pumps and fertility extending treatments such as egg-freezing (social freezing). Depending on the song, the breast pump is either a solo instrument or part of an arrangement. The idea is to use workplace lactation as a departure point to uncover a web of societal politics and pre-conceived perceptions (pun intended) of ideal and non-ideal motherhood.

1 DESCRIPTION

Summary

Bad Mother / Good Mother is an audiovisual performance involving a projection, a modified electronic breast pump as a sound generator, and a sound-reactive LED pumping costume. The project has four songs that critically explore technologies directed specifically at women like breast pumps and fertility extending treatments such as egg-freezing (social freezing). Depending on the song, the breast pump is either a solo instrument or part of an arrangement. The idea is to use workplace lactation as a departure point to uncover a web of societal politics and pre-conceived perceptions (pun intended) of ideal and non-ideal motherhood.

Fig. 1.
A still from a performance at the Situation Room in Los Angeles in February 2018

The Songs (audio and visual)

The audiovisual performance has four “songs” consisting of sound and connected visuals that are projected during the performance. In the first and last song, the breast pump is treated as the solo instrument, in the two middle songs, the breast pump sound is part of an arrangement.

The first song uses the breast pump sound as a solo instrument. Thematically, the song is about different aspects of pumping breastmilk at work. It has two basic sounds: The sound of the milk letdown which is slower and the sound of the pumping which is faster. In the performance, I am switching between the two modes, playing them at different intensities. The visuals are still images of different breast pumping situations and the stresses related to extracting milk in a work environment.

The second song is about maternity leave. In the US, parental leave is not mandated by law. The visuals show (US) politicans displaying fake reverence towards women. The breast pump is playing in the background, defamiliarized by vocoding. The third song is about freezing eggs to delay motherhood. Egg freezing is an elective medical technology that is sold to women as empowering because it allows women to delay motherhood by freezing their eggs. Because the motivations are social and not primarily medical, the procedure is also called “social freezing”. It is big business especially since large tech companies like Facebook have announced that they will pay for employees' eggs to be frozen. Facebook was criticized for using this "benefit" to pressure women to delay motherhood. As if successful employeehood was not compatible with motherhood. The song uses the breast pump as the heavily vocoded lead vocals in a cover of Daft Punk's "Get Lucky".

The fourth song is improvisation, using filters to distort different aspects of the sound signal. The visuals are of a woman pumping. Individual movements are repeated rhythmically along with the sound. It signifies the repetitiveness of the pumping routine.

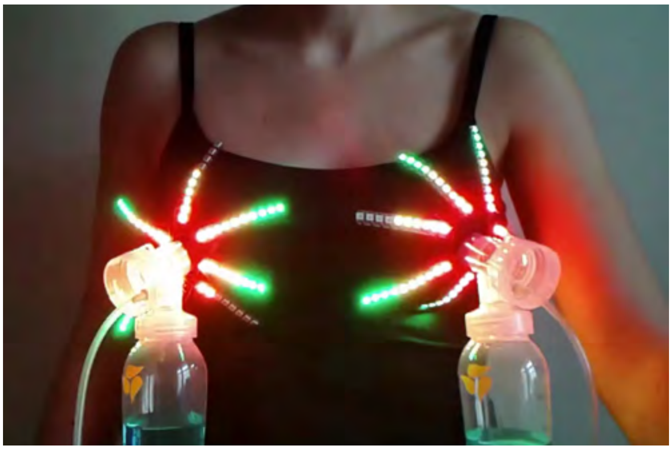

Fig. 2.
The Costume.

The Costume

The costume is an exaggerated pumping top. Around the cut outs where the breast pump shields attach to the breast, it has seven rows of LEDs pointing outward like a star. The LEDs are attached to a microcontroller board. Each arm represents a frequency band. The LEDs therefore pulse along with the sound. However, the bands are lit individually depending on the energy content in this frequency band. It is designed similar to a rock star's costume. It ironically glamorizes the profoundly unglamorous act of using a breast pump in a world where women are encouraged to breastfeed or pump in private rather than use their pump in public.

1.1 Media Assets

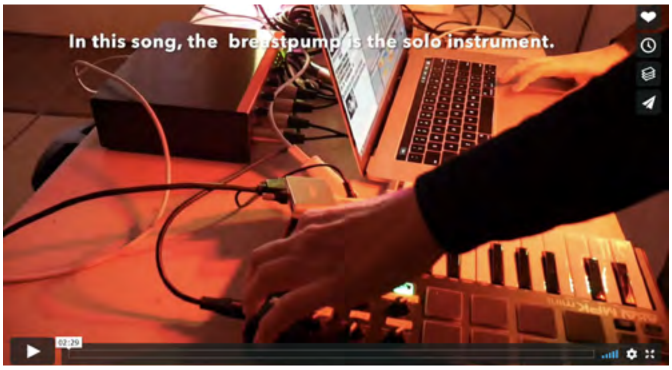

Fig. 3.
A video asset
(https://vimeo.com/262568142)

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Serrate No. 2

Keywords
mechatronic musical instruments
musical robotics
scraper-class percussion
yu
ancient Chinese musical instruments
new interfaces for musical expression
mechatronic art
gestural controller.

***Serrate No. 2* is a solo electroacoustic work that is performed by a human performer and *serraE*, an ensemble of mechatronic scraper-class percussion. *serraE* is developed by re-visioning the musical mechanisms of ancient musical instruments with new technologies. Using *g.qin*, a custom gestural controller, the performer brings together ancient and modern sonic territories by the choreography of sound and movement, across time, space, and between mediums. This work is part of a larger series of research that re-visions ancient musical devices using new technologies towards preservation, revitalization, and inheritance.**

1 DESCRIPTION

Serrate No. 2 is a human-mecha performance that features a human performer and *serraE*, an ensemble of mechatronic scraper-class percussion. serraE is developed by re-visioning the musical mechanisms of the *yu* (as seen in Fig. 1), an ancient Chinese scraper-class percussion used to indicate time in Confucian court ritual. The *yu* is played with the musical gestalt of striking the body of the percussion three times with a brush mallet and scraping once across the serrates

Fig. 1.
The Chinese yu (Zhao 2009).

Through re-visioning musical mechanisms of ancient musical instruments, the piece explores the amalgamation of ancient and modern sonic territories by the choreography of sound and movement across time, space, and between mediums.

Fig. 2.
serraE: A mechatronic scraper-class percussion (left) and *g.gin*, hand gestural controller.

The interaction between the performer and *serraE* (as seen in Fig. 2) is mediated by *g.qin*, a hand gestural controller, a 8x8 grid controller and a complex mapping scheme to afford expert control. This deviates from the traditional sequenced, and autonomous/intelligent performance model associated with mechatronic musical instruments performance, instead leaning towards performing them just as one would with a traditional instrument, such as a violin or piano. Table 1 illustrates the mapping scheme employed for each unit of *serra*.

Sound-producing Mechanism	Physical Attribute	Type of Control	Sound-producing Mechanism
Material	*serra* unit	Selection	Momentary button(s)
	Scrape/ strike	Selection	Hand posture(s)/ momentary button(s)
Solenoid - strike	On/ off	Excitation	Falling edge in hand stationarity
	Strength of strike	Parametric/ continuous	Magnitude of hand's linear acceleration
Servo - scrape	On/ off	Excitation	Falling edge in hand stationarity
	Speed of scrape	Parametric/ continuous	Magnitude of hand's linear acceleration

Table. 1.
An overview of *serra's* mapping scheme via *g.qin*.

Sonically, the piece explores the wide variety of timbres that may be extracted from *serraE*'s physical mechanisms, form, materials, and how these ancient sounds may be developed further into new sounds via both physical actuation and audio signal processing.

1.1 Media Assets

This video consists of excerpts from a past human-*serraE* performance. The proposed performance develops these elements into a new piece and focuses on the instrumentality of *serraE* in a live performance setting.

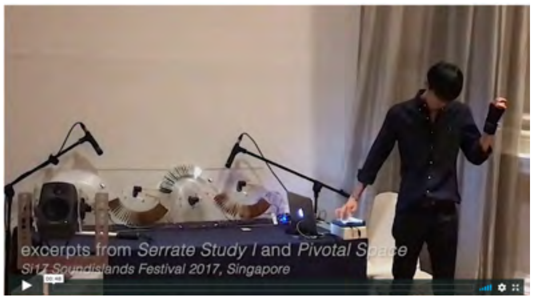

Fig. 3.
Excerpt of previous performance at Si17 Soundislands Festival 2017, Singapore. (https://vimeo.com/310240604)

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SKR1BL

Keywords
interface
embodiment
timing
mapping strategies and design
(un)control
aesthetic
sound art
design

SKR1BL (2016, c. 12mins) is an audio-visual composition for solo laptop performer with gestural controllers. The score consists of 'sampled' graffiti tags that are formally arranged to highlight similarity and variation, and to provide opportunities for sonic contrast and counterpoint. The performer creates fine detail through interpretive, intuitive and exploratory responses to the score, a sound library and DSP processes. The work is part of a wider study on the use of graphic notation in live electronics to create a body of work that falls in the gaps between improvisation and repertoire.

INTRODUCTION

Working from an extensive photographic archive of graffiti signature tags found in Edinburgh, isolated signatures are combined into morphological strings, considering the character of variations and repetitions of line, motion, gesture, grain, ornamentation and other visual aspects inscribed into the tag. The performer uses a graphics tablet to follow the overall form of the tags as an interface to sample based DSP processes in a MaxMSP environment. Typical tablet gestures include scrubbing and scratching, dipping, oscillation and bowing (Wessel et. al. 2002).

Graffiti scores are ideally suited to gestural interfaces such as the graphics tablet and stylus, not least because of the inbuilt link to penmanship and calligraphy. Graphics tablets allow us to re-scribe the gestures contained in the tags. This creates a shared energy and morphology, and we can develop the stable, scrutable, learnable response required for more sophisticated expression (Croft 2007). The base sonic material consists of fragments of early Hip-Hop that are distributed across a number of DSP layers. The graphics tablet and other controllers are used to trigger and scan material, which is subject to further processing and manipulation in a manner reminiscent of both early tape works and modern turntablism

Grounded in Hip-Hop culture, there's a musicality to tagging with rhythms and repetitions, and importantly, tags seem spontaneous and improvised, yet crafted and cultivated. The visual style is reductive, symbolic and object oriented. The morphology and material character of the tags guides the performer in respect of sound shape, texture and gesture such as granular microstructure due to combined qualities of a repetition, the graffiti surface and the marking paint or ink. The performer should look for established direction and extensions of movement and make connections in material though superimposition, stratification, juxtaposition, and interpolation. The overall duration of the work, and of individual passages, will vary as a function of the interactions between the different elements.

Graffiti tags are by turn angular, abstract, reductive, compressed, contained, expressive, expansive and iconic, with lines that connect and organise, shifts in weight, arcing trajectories, ASCII like decoration, punctuation and texture, with embodied formal and filigree qualities. This work is characterised by fast moving details, developments and interactions between sound objects and technique. The score provides a framework for returning to scripted play and guides the overall direction of the work. Tags may demonstrate some common gestures, but also contain improvised variations. At this stage the work is focused on human structuring, performance and remediation, but technologies for archiving and gesture following graffiti tags are available (Roth 2010, Caramiaux 2012), and the production of scores might develop by investigating processes of graffitization (Berio and Leymarie 2015).

Links between graffiti and the structuring and performance of music and sound can be found in the view that tagging is an embodied form of interiorised repetition of developing skills, style and serial objects (Brighenti 2010). It's possible to identify a mapping between formal expression of character, changes in direction and the speed of the gesture, "mak[ing] the most expressive mark possible in the fewest amount of lines in the shortest amount of time" (Roth 2009). The combination and contact of spray or ink and surface can map to malleability and fluidity in an object/substance field (Smalley 1996).

Design theory and literature such as Kandinsky's *Point, Line and Plane* (1926) provides some insight into ways in which the formal qualities of tags might be interpreted in musical ways as an aid to score creation. Kandinsky examines the tensions inherent in curves and angles. Tension refers here to the potential for movement and resolution. Like springs, curves and angles are lines under tension, and could potentially resolve to straight lines. Morphology and taxonomy offer additional frameworks for visual analysis (Roth 2009, Schaeffer 1966, Smalley 1997), while gestural and situated aspects of graffiti tagging can examined for indicative relationships (Smalley 1996).

The work addresses themes of performance and technology in the use of devices like the graphics tablet and 3D space navigator, embodiment in the re-mediation of graffiti signature, timing and flow, mapping strategies and design in the interaction of the different DSP layers such as inverse crossfades and useful ranges, and (un)control and unpredictability in the self-sampling processes as the performer's attention and intention shifts between layers. Visual processing of the tags used to create the score is mapped onto existing audio processes to allow for an embodied, embedded and closely integrated audio-visual performance (e.g. temporal and frequency-based manipulations.

Fig. 1.
Instances of collected graffiti tags, Edinburgh, April 2014

Fig. 2.
SKR1BL Score Fragment

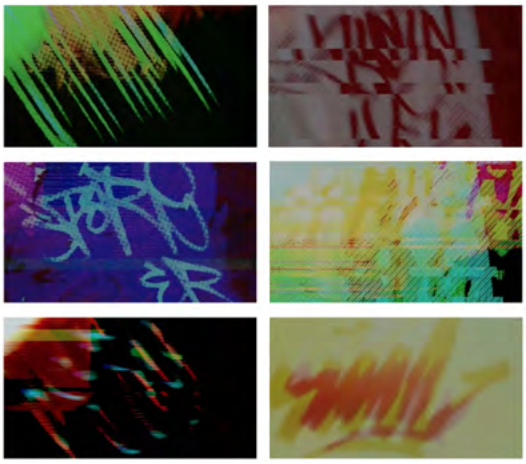

Fig. 3.
SKR1BL Frame Exports http://vimeo.com/155386533
More audio examples can be heard at:
https://soundcloud.com/pixelmechanic/sets/skr1bl

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Never The Less: A Performance on Networked Art

Keywords
Computer Music
Collaborative Instruments
Media Art
Networked Art
Interfacing Art

Never The Less **is a live audio-visual (A/V) networked performance, where participants are able to interact remotely and collaboratively. It adopts the newly-proposed web-based A/V** ***Akson*** **system, designed for an internet infrastructure, which allows both musical and visual content generation and interaction across multiple devices in remote locations. The system was built with great emphasis on live-performance and human collaboration, where experts and non-experts (i.e., artists and public) exist at the same level.**

1 INTRODUCTION

Networked technology, and in particular cloud infrastructure has been enhancing degrees of interpersonal collaboration across multiple areas of human knowledge. Art has been a privileged medium where pioneers have adopted the network to foster new means of communication and expression (Dixon, 2015; Broadhurst, 2007). These new means of communication stimulate new creative spaces where artists can promote their work through a distributed array of mediums (e.g., smartphones and tablets) and the role of author, in other words, meta-creator (Malloy, 2016; Akkerman 2014). Furthermore, it has profound impact on the reception of the artworks, shifting the role of the listener and viewer to participant (Morandi, 2017).

In this context, we present *Never The Less*, a performance that explores the interaction and generation of A/V content across distributed devices in a network. Aiming to push the boundaries of networked art accessibility and familiarity (Tribe & Jana, 2009), we adopt the web browser as the interface of *Akson* and explore the web technology as content and medium (Büsher et al, 1999).

2 TOWARDS AKSON SYSTEM

The performance *Never The Less* publicly presents a digital space where the public can interact with the performers on stage. To promote this collaboration, we use the recently designed *Akson* A/V networked system, which is both a controller and a playback engine. It runs on any personal device (e.g., laptops, tablets and mobile phones) with multimedia capabilities allowing both local and large scale distributed performances.

Akson uses server-side programming with *node.js* (Tilkov & Vinoski 2010). The code relies on the *Web Audio API* (Roberts, Wakefield & Wright, 2013; Wyse & Subramanian, 2013), the *WebGL API* (Parisi, 2012; Marion & Jomier, 2012) and the *socket.io* library (Rai, 2013). The dynamic linking of the latter allows us to define different modes of interaction between the terminals in performance (Renaud, Carôt & Rebelo 2007; Barbosa, 2003; Brown, 2002). *Akson* places itself on the internet with the willing to treat the browser as a canvas but also to use the robust potentiality of the Web. These provide us programming interfaces and open-source libraries such as *tone.js* (Mann, 2015) and *three.js* (Dirksen, 2013) that are currently being used in the underlying code of *Akson*. The platform is also ready to converge large scale playback with potentially global distances across the globe (McKinney, 2016; Chew, et al 2004; Bédat, 2002).

3 PERFORMING NETWORKED ART

When *Never The Less* starts, everyone can connect to the system and it multiplies itself every time a user effectively establishes the connection. We will present two of the four modes *Akson* can have. The multiple synthesizer instance proposed by Roddy (2018) is similar, and the multiple interaction methods explained by Todd Winkler (1998) that look at control issues are also covered in the development of the software. In *Never The Less* we perform in *The Conductor Model*, the paradigm of the *Symphony Orchestra* where the conductors are the master controllers shaping the dynamics and directing time flows. And the *Free Improvisation* method, based on the free jazz movement of the sixties that produced performances that were highly interactive, spontaneous, expressive and unpredictable. There will be a clear difference in the user experience on mobile phones, tablets and laptops. With small and less powerful devices the visual display will change automatically according to the connected user actions and in laptops it is possible to trigger a user interface to change visual and sonic properties.

On both the interaction methods explored in this performance, the users will be able to propagate synthesizer notes through the connected devices always with a coherent visual representation. Alongside that stream, it is also possible to control a filtered noise that acts as a second property of the instrument that doesn't propagate on other users. The performers will act as the overall conductors (Lippe, 2002) and playing in the main sound system in the venue. A method that will allow acoustical balance control and overall build of the artwork that has been used extensively on interactive composition (Winkler, 1998).

3 CONCLUSION

In this article we review the conceptual framework and technical taxonomies of the performance *Never The Less* that explore part of the *Akson* (A/V) collaborative system. The interaction that the public can have and a particular emphasis is given to some of the underlying technologies used. We also emphasize a relationship with the *wagnerian gesamtkunstwerk* (Koss,

2012) and a willing to seek a single medium of interactive collaboration in a digital environment.

The amount of artistic possibilities a digital network can have on human-computer interaction (HCI) is beyond the scope of a single performance, and certainly the restrictions on plural collaboration may change. *Never The Less* builds a public connection link in the north of Italy exploring multiple device collaboration on the specific methods defined earlier. The connected devices will act as a linking current between themselves and expanding a place of artistic creation as a vehicle and as content. This experiment is also immediately focused on the relevance, design and development of new collaborative applications to artistic performance but also helps evaluate existing systems of creative interaction (Fencott & Bryan-Kinns 2013) in a singular network.

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"Here we are now" Explorative, participatory text performance based on John Cage's *Lecture on Nothing*

Keywords
John Cage
text
repetition
participatory improvisation,
mixed-media performance

Through a simultaneous bilingual reading of John Cage's *Lecture on Nothing* coupled with a spatial, participatory choreography, our contribution invites audience interaction to explore the dynamics and effect of communication on shaping the aesthetic experience of the performers and the audience.
Our performance is based on a pivotal passage of the text and involves an improvisational play on the relation between human speakers and loudspeakers. Differences in sonic quality from sounds produced by speakers and that produced by the performers exemplify the roles of speech as sound and as a carrier of symbolic meaning, superimposed by technical mediation.

1 MOTIVATION AND CONCEPT

An early example of a lecture-performance, John Cage's *Lecture on Nothing* (Cage 1961) is a text meant to be performed and listened to, rather than just read silently. It explicitly refers to various aspects of a musical piece that are exemplified at the same time, for example, with respect to material, rhythm, structure, repetition, or form. Rather than a theatrical experience, we explore this *Lecture* on the lines of a radio-play via a simultaneous bilingual presentation, which involves Ernst Jandl's congenial German translation (Cage 1995). Our performance is based on a pivotal passage of the text and is coupled with a spatial, participatory choreography.

Our contribution departs from the fourth part of the *Lecture on Nothing*, which consists of seven almost identical reiterations of the base text sequence. In itself, this sequence shows self-similar repetitive elements and enables the radically self-referential function of the fourth part for the entire lecture. From today's perspective, the construction of this part alludes to techniques of algorithmic composition, automatic text generation and computation, for example, by numerical counting up of iterations as part of the narration. The bilingual simultaneous reading refers to the history of radiophonic art where this technique exploited two-channel stereophonic sound transmission and projection. At the same time, it carries the metaphor of multiple parallel strands of information in our surrounding, whose comprehension requires the psychoacoustic abilities of our hearing to segregate and segment, both spatially and temporally.

We regard the bilingual simultaneous reading combined with an explorative spatial choreography not so much as a novel interpretation *for* the audience but as an experiential engagement with the text by the audience (which comprises ourselves). We intend to push this bodily encounter even further. Our voices and moving bodies will be complemented by portable loudspeaker sculptures that emit textual meta-layers to the *Lecture*. The spectators are invited to undertake the portable speakers based on ad hoc instructions that are part of the meta-layers themselves. Instructions, or invitations, may involve moving in a certain direction or turning around, thus directing the sound, or passing on the speaker to somebody else.

Our contribution explores the relation of human speakers and loudspeakers, its effect on communication and how this shapes the aesthetic space. Differences in sonic quality from sounds produced by speakers and that produced by the performers exemplify the roles of speech as sound and as a carrier of symbolic meaning, superimposed by technical mediation. In addition, the participation of the audience shapes a social field around the common act of aesthetic experience.

2 DEVELOPMENT PROCESS

Our engagement with Cage's *Lecture on Nothing* began during the BASE residency "In a Silent Way: On the Significance of Silence in Philosophy, Arts and Contemporary Forms of Life" between December 2017 and March 2018.

While the exploration developed in Palani Hills, Kodaikanal, India, the first performance of simultaneous, bilingual reading integrated with a spatial choreography was held as part of the residency in Madurai, India (Jan 2018). In the cumulative artistic research performance staged in Jawaharlal Nehru University (JNU), New Delhi (Mar 2018), a shortened two-minute version was designed to include visual text, its semantic content translated through dance and read in English. In addition, a randomised selection of bilingual recorded snippets of the lecture were played to usher the audience into the space of the collective performance. A third innovative attempt to explore the spatial relation to sound was much appreciated at "Exploring Formats, Exploring Practice" at MUMUTH, Graz (Oct 2018). The most recent rendition of this piece was in "Intervention! Intoxication?" – a Performance Philosophy Biennale, Amsterdam, where a ten-minute audio essay version of the recorded simultaneous bilingual reading was played including a third audio, semantic layer of instructions for the audience. This complex sound piece was designed, intending the physical absence of the two performers (Mar 2019).

Fig. 1.
John Cage: *Lecture on Nothing* (full-length performance) at *Exploring Formats, Enriching Practice*. A Research Event, Graz/Austria, October 12, 2018

The current interpretation at xCoAx has emerged from our repeated engagement with Cage's Lecture through varied formats, each variation exploring a new aspect – sonic, aesthetic, semantic, technological, linguistic, computational – that this text affords.

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Doctoral Symposium

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Machine Vision in Digital Art

Keywords
machine vision
digital art
object recognition
machine learning
neural networks
facial recognition
emotion detection

Machine Vision has become a part of our daily life. Technologies, such as object recognition, facial recognition and emotion detection, are increasingly used to turn images into information, filter it and make predictions and inferences. As a part of the *Machine Vision in Everyday Life* team, I will contribute in developing a database of approximately 1000 works of digital art, games and narratives using or referencing machine vision. We will map and categorize this material to find patterns that may help us understand the broader cultural understandings of machine vision in society. Furthermore, I will use digital artworks to analyze two emerging commercial applications of machine vision, *Queryable Earth* by *Planet* and emotion AI technology by *Affectiva*. The first focuses on satellite images and object detection systems and the second on facial recognition and emotion detection technology. By investigating *Queryable Earth* and emotion AI I will be questioning a tech industry rhetoric of an all-seeing, all-feeling objective machine vision by exploring the limits of machine vision and how machine vision is hacked, bent and repurposed by artists.

1 PURPOSE OF THE RESEARCH AND ITS IMPORTANCE TO THE FIELD

Vilém Flusser recognizes two fundamental turning points in human culture. The first is the invention of the linear writing and the second he calls "the invention of technical images" (2000, 7). According to Flusser the "magic" of images was lost when the elements of the image (pixels) were transcoded into linear writing (2000, 10). Now each pixel of a digital image is assigned a concept, a value, and the numbers are arranged into machine readable lines of code. Artist Trevor Paglen argues that during the last decade visual culture has dramatically changed. The human eye is detached from the images and the machine-to-machine vision is generally invisible (Paglen, 2016). Nevertheless, the invisible images have an impact on our everyday life. Multibillion-dollar investments in object detection technologies assume that it is easy for computers to extract meaning out of images and render our bodies into biometric code (Magnet, 2011), yet trial and error approaches have already revealed that machine learning is far from objective and emphasizes existing biases (Buolamwini & Gebru, 2018). It is often very hard to determine how applications relying on neural networks reason, hence artists interacting, playing, hacking and experimenting with machine vision are trying to understand what the machine sees. Paradoxically, digital artworks can both critique the objectivity of machine vision as well as use it as evidence to support a statement, hence they provide rich material to answer my research questions: 1) How is machine vision represented in digital art? 2) What limits of machine vision can digital art reveal? 3) How are artists hacking, bending and repurposing machine vision? This thesis is groundwork aiming to fill "a research gap on the cultural, aesthetic and ethical effects of machine vision." (Walker Rettberg, 2017).

2 BACKGROUND AND RELATED WORK

2.1 The Machine Vision project & Artistic background

My PhD positions is a part of a European Research Council project called *Machine Vision in Everyday Life: Playful Interactions with Visual Technologies in Digital Art, Games, Narratives and Social Media* at the Department of Linguistic, Literary and Aesthetic Studies, Faculty of Humanities, University of Bergen. The multidisciplinary Machine Vision project is led by professor Jill Walker Rettberg. My focus in the project is to analyze digital art. Additionally, since 2010 I have worked as an artist collaborating with Andreas Zingerle forming the artist duo Kairus. Our artworks and research include topics such as surveillance, smart cities, IoT, cybercrime, e-waste and machine vision.

2.2 Related work

Digital art has been considered to challenge systems of knowledge (Shanken, 2002), render the invisible visible (Cirio, 2017) and express what it feels like to live in the age of digital computing (Broeckmann, 2006), hence digital art offers an opportunity to explore various aspects of machine vision in our everyday life. Machine vision in digital art has been explored to some extent (e.g. Hoelzl & Marie, 2015; Bjørnsten & Sørensen, 2017). Writings about neural aesthetics, as in artworks assisted by neural networks, have mainly focused on human-machine collaboration in producing art (e.g. in a special issue of digimag 76, Bertolotti & Mancuso (Eds.) 2017) and questioning if machines can be creative (du Sautoy, 2019). My approach on machine vision will benefit of a a multidisciplinary set of theory. For example; theory on photography, cinematography and digital image (Farocki, 2004; Flusser, 2000; Hoelzl & Marie, 2015; Mitchell, 1992; Paglen, 2014; Viriollo, 1994/1989), practices of mapping the world and theorizing the aerial perspective (Cosgrove, 2008; Bousquet, 2018), histories of objectivity associated to the scientific image (Daston & Galison, 2010) and critical data studies (Apprich, Chun, Cramer, & Steyerl, 2019; Halpern, 2014) will provide a theoretical framework when close reading *Queryable Earth*. Media, communication and culture studies on biometrics (Gates, 2011; Magnet, 2011), affective computing (Picard, 1995), some studies in brain research and psychology (Tuschling, 2014) as well as media and algorithmic studies (Cheney-Lippold, 2017; Eubanks, 2017), will assist to form a framework to connect identity, body, face, and emotions, when analyzing emotion detection technology used by companies such as Affectiva.

3 APPROACH

My research questions will be explored in 3 articles. For the first article I will be collaborating with the Machine Vision team. We will conduct a distant reading using network analysis to find patterns in how digital artworks, games and narratives represent machine vision. In the two following articles I conduct close readings on two case studies *Queryable Earth* and *Affectiva* to critically inspect how emerging commercial prediction products apply machine vision and machine learning technologies. As a main theoretical framework, I will use N. Katherine Hayles' "nonconscious cognitive assemblage" (2017) in parallel with digital artworks as examples, as I aim to show how human, technical and material components interplay in complex machine vision systems.

4 EXPECTED CONTRIBUTIONS

I will be able to present a sample corpus of digital art that contextualizes my approach to machine vision, guide you through the thought process of tagging and creating the database, presenting early visualizations of the network analysis. In addition, I wish to discuss my approach to close read two cases of emerging technology using the presented theoretical framework and digital art.

5 PROGRESS TOWARDS GOALS

I have started my PhD January 2019; hence I am still very much at the beginning of my research. During the spring term 2019 I will be working with the database together with the project team and finish my project plan.

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Aby Warburg's *Mnemosyne Atlas:* An Iconology of Difference

Keywords
Aby Warburg
digitisation
diversity
(im)materiality
patterns
pluralism
pragmatics
repetition

This research paper engages with the digitisation of Aby Warburg's *Mnemosyne Atlas* by problematising the appropriation of Warburg's body of work within contemporary digital discourse. Investigating how the digitisation supports a tendency to accentuate the similarities between the photographic reproductions assembled on the panels, I will highlight the discrepancies between individual entities and larger collective patterns within databases more broadly speaking. In criticising the inclination to equate the analogue and digital versions of the *Mnemosyne Atlas*, I examine the possibility of how a pluralistic engagement with Warburg's panels might reveal where the imposition of image recognition and pattern discrimination on larger quantities of data are irreconcilable with the diverse material constituting the mass in mass digitisation.

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The Sounds of Obsolescence in the Age of Digital Re-Production

Keywords
media archaeology
practice-based research
obsolescence
sound installation

This practice-based research focuses on creating a series of sound sculptures that establish a narrative between the past and present through the convergence of obsolete and current media technologies. Within the transdisciplinary frame of media archaeology, new methods of inquiry into the obsolete object's engagement and relationship with current media technologies may emerge that defamiliarize current narratives. Using a practice-based research approach, the process of defining, producing and refining the art works will be supported by an exegesis that contextualises and interprets the knowledge embodied in these works. By discursively revealing aesthetic and artistic intentions in this way the artefact and the process of its creation become sources of embodied knowledge and artistic method. This research contributes to existing practice-based discourse by providing new insights into the process of making, interpreting and contextualising sound-based art informed by media archaeology.

1 INTRODUCTION

This practice-based research uses the "potentials of the media archaeological method" to provide a rich vein of information from which to conceptualise and create object-based sound installations (Parikka, 2012, 2). The novelty is that by articulating the research as media archaeological, the works are explicitly contextualised and the research is engaged as such, an approach which is relatively uncommon. As an art practice, the object-based sound installation (which works with physical artefacts rather than sound alone) can be one way of re-presencing the obsolete object and its relationship alongside new media technologies. Informed by media archaeology, new perspectives on the object can emerge that defamiliarise common historical narrative. As a method of research, writing about the making process can reveal the artist's aesthetic and intellectual intentions and experiential knowledge that may otherwise be left to an audience's interpretation. By writing about the creative process, and my aesthetic and intellectual intentions, in conjunction with analysis of the artefact itself, I therefore aim to articulate insights into my artistic practice, its relationship to the cultural context and theoretical practices which inform it, and to do so in ways that will inform future work.

2 RELATED WORKS

Characteristics of the object-based sound installation and/or a media archaeological approach provide a lens to interpret works and gain insights into the relationship between old and new media, the artist and the audience and the artist's relationship with the artefact. Examples include Ethan Rose's *Reflection*, Martin Messier's *SEWING MACHINE ORCHESTRA* and *Projectors* and Zimoun's works using common objects such as cardboard boxes and small motors. Nicholas Bernier has drawn inspiration for his sound-based art from historical ideas and objects. An example, *Frequencies (A/Oscillation)*, draws from the experiments of 19th century physicist Jules Lissajous who first discovered a method for visualising sound. Paul DeMarinis is an artist who adopts a media archaeological approach to create works that "construct alternative and hypothetical media histories." (Parikka 2011, 14) Examples of this approach include *The Messenger, Gray Matter* and *Firebirds*. The author's own work, *Click*, is an example of the media archaeological method used to conceptualise and create an object-based sound installation (Dunham et al. 2018). A series of Brownie Box cameras is re-presented in a quasi-digital context, disrupting a commonly held belief of analogue as old and digital as new. Recontextualising the Brownie Box in this way defamiliarises the presentation of digital information through a familiar medium.

3 METHODOLOGY

Initially, a framework of practices proposed by Graham Sullivan will provide the basis for the research methodology. He suggests that by delving into "theoretical, conceptual, dialectical and contextual practices through artmaking", the artist-researcher can take an audience "to where we've never been, to see what we've never seen" then "they bring us back and help us look again at what we thought we knew." (Sullivan 2009, 62) The author will create a series of artefacts that establish a narrative between the past and present through the convergence of obsolete and current media technologies. An exegesis will give each artefact a voice, revealing the embodied knowledge that has been collected and preserved by the author through the process of making.

4 CONTRIBUTION

An approach informed by media archaeology to create sound-based art can provide the possibility of new and unexpected insights into the object as a *"temporally displaced"* artefact within the present (Burges 2013, 90-91). The practice-based method further extends the existing bodies of knowledge in this field, in media archaeology informed sound-based art and as a unique contribution across all three areas of research and practice.

5 PROGRESS

The research is progressing towards the submission of a full research proposal. An audio-visual installation based on the sonification of a mid-20th century book of random number tables has been completed and exhibited. A second sound installation based on the juxtaposition of telegraph technology with current communication media is currently in development.

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Multi-sensory transformation of biological signals

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The aim of this Ph.D. project is to transform the physical behaviors of living cells into multi-perceptional experiences for a wide range of audience based on the combination of both scientific and artistic methodologies. Applying contemporary scientific research methods, with an artistic research method is an unconventional approach to understand our environment and ultimately the research question that has driven my work as a researcher and life. In this study, the smallest discovered unit of life will be examined in a new way, to open up our thinking about the multi-scalar systems of relations between human, and non- human living beings and technology. This can lead us to the human and non-human and post human discourses which can broaden the insight of humanities and aesthetics in general in relation to how there relations are valued both environmentally and through perceptual systems. Furthermore, this study contributes to the field of digital data processing as well as analogue technology to create a tangible musical interface. This project could encourage active exchanges between any array of diverse academic disciplines, from artist, scientist, ecologist, anthropologist, and physicist, that can generate new knowledge thought their collaboration and questioning through looking at the knowledge stored in the microbial scale of life.

1 PURPOSE

This research aims to create multi-perceptional transformations of biological signals from human cells into artistic frameworks based on scientific significances in bioscience domain such as biophysics, molecular biology, and nanobiotechology with questions: how a work of art can be aesthetically represented as an interactive performative installation, and how through the experience of this environment, become a reference to the sonic interactions between living cells, and human sensory perception. Biological noise is derived from various kinds of communications between intraspecies (cell to cell), interspecies (a process of gene expression) such as decision making on dynamics of protein conformation — growth, death, inflammation, disease, etc (Balázsi, et al. 2011).

This study is focused on the physical mode of communication types, specifically motion, vibration and frequency. There is some experimental evidence that microorganisms can generate, and respond to physical signals such as sound waves, electromagnetic radiation (e.g. biophoton) and electric current (e.g. nanowire) (Reguera 2011). The advantages of physical signal cell communication are that it requires less energy consumption than chemical signaling, which means that information delivery through physical signals (e.g light and sound) can respond faster and wider. However, human senses are limited to a certain range (the human audible range is 20Hz to 20kHz and visible light region ranges in wavelength is 400-750nm), so the biological noise (signal) has to be translated to be perceptible by either amplifying (e.g. audification) it or transforming (e.g. sonification) it.

With advanced technology such as genetic engineering, and super-resolution microscopy, biological entities have been used, and analysed physically and chemically in artistic frameworks. However, most of the current sound, and music projects often focus on measuring biochemical energy rather than physical observation. Further artistic practice in musical expression of biological material can be more engaged with materialistic nature and physical attachment of our perceptions such as physicality and tactile perception including a multi-sensory transformation of biological data.

2 BACKGROUND AND RELATED WORKS

Using high-resolution technology such as an Atomic Force Microscopy (AFM), we can record cellular nano-mechanics in an acoustically insulated environment. A single yeast cell creates periodic nanoscale motion at the temperature-dependent frequency of 0.9 to 1.6 kHz with an amplitude of ca. 3nm (Pelling, et al. 2004). Also, molecule's unique vibration is related to olfaction, and it can be synthesised by replicating a certain vibrational frequency. For instance, methyl sulphide has 256 wave numbers and its audible frequency is 256 Hz, and synthesised sulphur-hydrogen molecular bond vibrates at around 76 terahertz (76 trillion oscillations per second) (Turin 2005).

The discoveries, and techniques from scientific researches in biological noise have become the intellectual catalyst to artist, and scientist collaborations within the context of artistic research practices. In an audio-visual installation “Blue Morph (Vesna 2007)”, AFM was used to record the sound of morphology of pupa by observing the process of growth for one week.

“CellF (Ben-Ary 2016)” uses bioelectrical signals of his own cells to create an autonomous musical instrument. He extracted his own skin cells, turned them into stem cells, and then transformed them into a neural network. The neural network grew on a MEA system which has 60 electrodes and is connected to a custom-built analog synthesizer.

Within the field of biophysics, observing the physical movements, and recording there biological feedback in search of creating new knowledge of relations out of a large quantity of noise is also one of the aspirations of this research trajectory through artistic experimentations. One of the many challenges in this form of observation using microscopy technology, and detectors is that each device has precise limitations in filtering out the noise. The molecular scale also reflects the same noisy nature of human life, a lot of noise can be observed when a cell molecular is being scanned, or detected by machines. The noises are complex numbers which have characteristics of amplitude, and phase. In order to process the massive amount of noisy data, the computational process is inevitable. For example, David Glowacki and the University of Bristol researched a molecular dynamics into an audiovisual simulation. They calculated free energy and sonified the data by using the Markov State Model algorithm and an open source visualization program called PyMol (Glowacki, et al. 2018).

3 APPROACH

The goal is to create a performative installation based on current scientific findings of biological noise and the interaction between living cells and humans. It is a challenge because of technical difficulties, and it requires therefore research procedures carried out within a biological science lab for the process of extracting the human cells from the host to detecting cell behaviors. The detailed detection technology will be decided based on what types of behavior the specific cell displays. Besides sonic recording the motion of cells, other physical evidence methods such as electrical signals could be examined with biophysicists’ advice.

After anatomical research on an array of cellular types, I have decided the heart cell is the strongest candidate because of its musical characteristics, arrhythmias, and pulsations. The heart cellular modulation, and rhythmic pulsation can be compatible with the fundamental feature of sound. Other parts of human cells also have potentials to be examined such as the brain, muscles, liver, and kidney. These could be examined to detect the different characteristics of vibrations in physiological nature such as blood pressure, heart rate, respiration, EEG measurements, body temperature and galvanic skin response; alter immune and endocrine function; and ameliorate pain, anxiety, nausea, fatigue and depression;

living being's consciousness (Homma, et al. 2008). In this sense, it would be interesting to investigate the interaction between human cells and living beings by observing different types of bio-feedback.

Other methods of observing cellular noise such as biochemical signaling, as well as computer science will also be incorporated within the research experimentation. Especially the computer data processing, which is very helpful in simulating cellular activities. A huge amount of data analysing cannot be separated from the computational process. Also, a large body of research in contemporary bioscience have exemplified that interdisciplinary cooperation can lead to the best understanding of life mechanisms. In this sense, this research will not be limited to one discipline for successful completion of the project, rather the social relationships across disciplines, and fields of research will become the foundation of creating a meaningful representation within the context of an artistic practice. Therefore, this research requires interdisciplinary collaboration between art, and the multiple fields of science as well as a rigorous study of post digital media.

4 EXPECTED CONTRIBUTIONS

This research is an interdisciplinary project between art and science in the context of post digital media. The work can contribute to establish an interdisciplinary perspective to develop the work aesthetically based on scientific research, and to push forward boundaries between art, and scientific disciplines. The research outcomes will be submitted to related academic conferences, and to relevant journals to be published. Moreover, as an artwork, it will be presented to the public such as media art festivals, exhibitions, and talks. Archived documentation and hands-on workshops could be introduced to open source communities.

5 PROGRESS

This research is in the very early stages of its development, which has taken form in the process of reading and collecting appropriate reviews. In order to find a solution for proper technical expertise, this project is currently collaborating with AFM group in Institute for Biophysics at Johannes Kepler University in Linz. While the detailed experiment schedule is to be discussed, we are establishing background knowledge by attending relevant bioscience courses and conferences.

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Speculating on Artificial Intelligence from Early Photography to Contemporary Design

Keywords
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Focusing on diverse examples of technologies that have redefined the way humans experience reality, ranging from early experiments with photography to contemporary applications of machine learning and AI creativity, the study locates the history of artificial intelligence within the discourse on perception. It applies media theory to these instances of design speculation – on users and their needs – to 'distill' the fundamental (and contradictory) human desires materialized through media technologies – to eventually rethink what we imagine as a desirable future for AI-human interfaces.

1 BACKGROUND: APPROACHING THE ARTIFICIAL

There is a passage in *The Critique of Judgement* in which Kant refers to 'someone who [...] considers the beautiful shape of a wildflower, a bird, an insect,' to argue that any interest in the object should disappear 'if someone had secretly deceived this lover of the beautiful and had planted artificial flowers [...] or had placed artfully carved birds on the twigs of trees, and he then discovered the deception.' Kant employs this example to demonstrate that 'art can only be called beautiful if we are aware that it is art,' even if 'it looks to us like nature' (Kant 2004) – that art is not artifice and aesthetic experiences cannot rely on deception. Does the anecdote accurately depict our attitude towards the artificial? What if it were not art, but technology, that we were thinking of? And not just any technology, but artificial intelligence – in place of artificial flowers? Writing almost two hundred years later on the history of artificial intelligence, Pamela McCorduck concludes we are 'ten times more fascinated by clockwork imitations than by real human beings performing the same task' (McCorduck 2004). Perhaps human desire is more paradoxical than Kant's anecdote suggests. Sometimes, it seems, our satisfaction hinges precisely on getting tricked.

2 PURPOSE: RETHINKING AI EXPLAINABILITY

The question of technological mimicry posed indirectly by Kant and McCorduck could be translated into the language of design: what does the user need to see/understand when he or she comes in contact with AI systems? Must benevolent AI technologies strive for 'transparency'? And if so, what would that mean? In my work I draw on elements of media theory to locate the inquiry into AI explainability within the media-philosophical discourse on seeing/knowing – to eventually ponder new ways of deconstructing technological imitation and to speculate on the future of AI-human interfaces.

The goal of this project is thus not to seek the origins of current experiments in the field of artificial intelligence in the early developments of machine vision, or to draw up a linear narrative of technological progress, but rather to expose new ways of interpreting the imaginings and desires of the early dreamers and modelers of 'artificial retinas' (Nicephore Niepce on photography), 'independent creative intelligences' (Dziga Vertov on the camera), and 'neural daguerreotypes' (Google AMI group on GANs), investigated side by side, in the persistent present. My interest lies in the concepts of vision and visualization, knowledge and data, aesthetics and design, subjectivity and objectivity, the machinic and the artistic – as materialized through these inventions.

Desire, as I argue, is inscribed into the technologies – designed to, at once, technologize objectivity and synthesize consciousness, to both mechanize the nonhuman point-of-view and to reproduce human perspective on a wider scale. My approach towards the history of machine perception reimagines its trajectory as that of speculation: on the users and their future realities. Designers, as Anthony Dunne and Fiona Raby rightly argue, 'deal with fiction all the time – meeting imaginary needs of imaginary users' (Dunne and Raby 2013). My focus is precisely on those speculative fictions.

3 APPROACH: AI IN MEDIA THEORY

My plan to contextualize AI interface design within the history and theory of perception has been influenced by media historians such as Jonathan Crary, Orit Halpern and Siegfried Zielinski, as well as media theorists and philosophers of technology such as Vilém Flusser, Bernard Stiegler and Antoinette Rouvroy. In her book *Beautiful Data*, Halpern focuses on the historical construction of vision and cognition and, following Crary, posits that 'our forms of attention, observation, and truth are situated, contingent, and contested and that the ways we are trained, and train ourselves, to observe, document, record, and analyze the world are deeply historical in character' (Halpern 2015). My commitment to the approach that combines the history of perception, philosophy of technology and theory of technological design relates to the combination's potential to uncover in those moments of technological shift that came to redefine vision traces of long-standing and conflicted human desires that have guided our ambitions until today.

It is important to note that my work is not that of a media archeologist. According to Siegfried Zielinski, 'for some in the media, "archaeology" has come to supplant basic history, replacing it with a form of material retrieval—as if the preservation of materiality was tantamount to preserving history itself' (Zielinski 2013). Accepting that a mere reconstituting of 'old' media objects into 'new' contexts is not enough (and avoiding what Zielinski calls 'techno-retro-kitsch'), I approach the 'genealogy' of desire as a way of speculating on the drives that have informed technological design in the past and can still be traced in contemporary design today.

4 PLANNED CONTRIBUTIONS: THE FUTURE OF AI INTERFACE DESIGN

In the 1990s Paul Virilio wrote of artificial vision as a means of delegating the analysis of objective reality to a machine: 'Once we are definitively removed from the realm of direct or indirect observation of synthetic images created by the machine for the machine, instrumental virtual images will be for us the equivalent of what a foreigner's mental pictures already represent: an enigma' (Virilio 1994). Friedrich Kittler expressed similar concerns, as he argued that modern media technologies –since the invention of film and gramophones – are 'fundamentally arranged to undermine sensory perception.' According to Kittler, the computing community 'places all its stock in hiding hardware behind software, and electronic signifiers behind human/machine interfaces' (Kittler 2014). He even refers to a 'system of secrecy' based on user interfaces that 'conceal operations necessary for programming' and thus 'deprive users of the machine as a whole.' Today, we produce new technologies to see, know and feel more, to register what is normally hidden from our view – meanwhile, creating complex systems based on multiple, invisible layers and arcane algorithmic operations whose effects are not always comprehensible even to the designers themselves. This kind of design that strives for the enhancement of vision invariably results in a form of blindness.

Vilém Flusser argued that a renewed form of culture, enabled by self-conscious design, would have to be a culture 'aware of the fact that it was deceptive' (Flusser 1999). Rethinking the question of AI explainability and design through media philosophy allows us to pose questions on visibility in relation to (future) design thinking. What do we want to see and what do we need to see as we come in contact with AI systems? Can seeing through the illusion of technology still guarantee satisfaction? Or has the 'trick' always been based on delegating perception to the machine, on seeing less? And if so, what kind of desirable futures of AI-human interfaces can we still envision?

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